



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION I

J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

CERTIFIED MAIL- RETURN RECEIPT REQUESTED

January 16, 1991

Dr. James E. Crowley  
Director, Environmental Control  
Ciba-Geigy Corporation  
444 Saw Mill River Road  
Ardsley, NY 10502

NAME: Ciba Geigy  
ID. NO.: R1D001154/323  
FILE NO.: R-9  
OTHER: \_\_\_\_\_

RE: Ciba-Geigy Consent Order: RCRA Docket No., I-88-1088  
RFI Proposal - Approval - Cranston, RI Facility

Dear Dr. Crowley:

The EPA has completed its review of Ciba-Geigy's RCRA Facility Investigation (RFI) Proposal, RFI Phase IA Report, and amended RFI Proposal submitted on April 2, 1990, October 24, 1990, and December 10, 1990, respectively. In accordance with Section II of the Consent Order, the Agency has approved the RFI Proposal (Phases IA & IB) submitted on December 10, 1990 under the condition that the following modifications are implemented.

- 1) Minor changes to the December 10, 1990 amended RFI Proposal as discussed with Mark Houlday of Woodward-Clyde Consultants on January 10, 1991 must be incorporated. These changes are as follows:
  - \* Submittal of Figures 2-1 and 2-2 in Volume 1, Chapter 2, Section 2.
  - \* A correction to Table 4-1 in Volume 1, Chapter 3, Section 4 and the same correction to Table ES-1.
  - \* Further clarification of the monitoring program for AOC-13 as found in Volume 1, Chapter 3, Section 4, page 4-36 (first paragraph); and corrections on pages 4-36A & 4-47.
  - \* The submittal of Figure 4-2A in Volume 1, Chapter 3, Section 4.
  - \* The submittal of pages i & ii of the Organic Region I Data Validation Worksheets in Volume 2, Part A, Appendix B and the submittal of other proposed changes to this Appendix.

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- 2) The recommendations outlined in Sections 6.3 & 6.4 of Volume 1 of the approved RFI Phase IIA Report must be implemented as part of the approved RFI Proposal.
- 3) The completion of the tasks in item two (2) above and their inclusion into the Phase I Interim Report and Phase II Proposal must be accomplished within the timeframes specified in item four (4) below.
- 4) All Phase I field tasks, the Phase I Interim Report and Phase II Proposal shall be completed within the timeframes outlined in Volume I, Chapter 2, Section 5, Figure 5-2 (Tasks No. 5-13) of the approved RFI Proposal. EPA will expect to receive the Phase I Interim Report and Phase II Proposal thirty (30) weeks after receipt of this letter. Failure to meet this deadline may be cause for EPA to demand stipulated penalties as required by the Consent Order.

As a result of these conditions, a final RFI Proposal with all the changes and additions described above must be submitted to the EPA Project Manager by February 4, 1991.

If you have any questions, please contact Frank Battaglia at (617) 573-9643.

Sincerely,

*Frank Battaglia*

*for* Gary B. Gosbee, Chief  
MA & RI Waste Regulation Section

cc: Carol Wasserman, Office of Regional Counsel, EPA  
Mark Houlday, Woodward-Clyde Consultants



NAME: Ciba Geigy  
I.D. NO.: RID 21194323  
FILE LOC: R 7  
OTHER: \_\_\_\_\_

EPA \*  
ADM. RECORD

**RCRA FACILITY INVESTIGATION PROPOSAL**  
**CIBA — GEIGY FACILITY**  
**Cranston, Rhode Island**

**Volume 1 of 3**

**CURRENT ASSESSMENT SUMMARY REPORT,  
STRATEGIC PLAN, AND  
FACILITY INVESTIGATION WORK PLAN**

Submitted by:

**CIBA — GEIGY Corporation**

444 Sawmill River Road  
Ardsley, New York 10502

REC'D  
2/8/91  
F.B.

1 February 1991

NAME: Ciba Geigy  
I.D. NO.: R1D041194323  
FILE NO.: K-9  
OTHER: \_\_\_\_\_

**RCRA FACILITY INVESTIGATION PROPOSAL  
CIBA – GEIGY FACILITY  
Cranston, Rhode Island**

**Volume 1 of 3**

**CURRENT ASSESSMENT SUMMARY REPORT,  
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1 February 1991

#### **DISCLAIMER**

Nothing in this RCRA Facility Investigation Work Plan is intended to modify any provision of the Consent Agreement and Order (RCRA Docket Number I-88-1088). No approval by the United States Environmental Protection Agency of the RCRA Facility Investigation Work Plan shall in any way be deemed a waiver or modification of said Consent Agreement and Order.

## **Executive Summary**

**RCRA FACILITY INVESTIGATION  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND**

**EXECUTIVE SUMMARY**

**INTRODUCTION**

An RCRA Facility Investigation (RFI) is being undertaken at the former CIBA-GEIGY Corporation manufacturing facility in Cranston, Rhode Island (i.e., the site), pursuant to a Consent Agreement and Order ( hereafter simply called the Order) entered into by CIBA-GEIGY Corporation and the United States Environmental Protection Agency (USEPA). This RFI Proposal contains the work plan for Phase I of the RFI.

This is the first of four phases. The RFI entails two field investigation phases. Phase I will consist of site characterization tasks including sampling and monitoring of selected environmental media to identify any remedial actions required. The Phase I report will be submitted at the same time as the Phase II proposal. Phase II will focus on selection of appropriate corrective actions for each medium with additional environmental sampling, if needed. The RFI Report will be submitted to USEPA within three months after the completion of the Phase II field work. This report will include the proposed Media Protection Standards. A Corrective Measures Study Proposal will constitute Phase III of the project. Phase IV will be the Corrective Measures Study Report.

Phase I tasks (as detailed in the Order) include characterizing the on-site and off-site geography, geology, and hydrology as well as the sampling of all Media of Concern for all SWMUs/Areas of Concern both on-site and off-site. In addition, chemical analyses of designated media shall take place. Proposed indicator chemicals to be used in future sampling will also be identified.

Phase II tasks include additional geophysical surveys on-site and off-site as necessary, further sampling of all Media of Concern, and any other proposed sampling both on-site and off-site. In addition, Phase II shall include the analysis necessary to propose Media Protection Standards, as well as the proposal of those standards for all hazardous waste and hazardous constituents released from SWMUs and Areas of Concern at the facility.

Phase III tasks include the proposal of corrective measures to be investigated to achieve the Media Protection Standards and a justification for the selection of the corrective measures to be investigated.

Phase IV tasks include the investigation of the proposed corrective measures and the submittal of an assessment as to which corrective measure could be pursued to meet the Media Protection Standards, as well as a recommendation as to which corrective measure is best suited to meet the Media Protection Standards.

The Current Assessment Summary Report reviews the environmental conditions at the site. Chemical manufacturing activities took place at the site for over 50 years, ending in 1986. Planned activities are described for evaluating potential risks to human health and the environment associated with site-related chemicals for both current and future use scenarios. The approach for selecting appropriate corrective measures is detailed where corrective measures may be necessary to reduce risks to human health and the environment. Additional documentation is supplied regarding project management, quality assurance, and health and safety planning for the project.

## **CURRENT ASSESSMENT SUMMARY REPORT**

The site is located in an urban setting in the communities of Cranston and Warwick, Rhode Island. The site adjoins residential areas to the north and south, a

commercial area to the east, and open land (which was formerly the site of an industrial facility) to the west. The site slopes gently toward, and is divided by, the Pawtuxet River. Based on 30-year annual averages, precipitation usually exceeds 40 inches of equivalent rainfall. Records show the predominant wind direction is from the northwest.

Geologically, the area consists mainly of continental clastic sediments overlain with layers of glacial outwash, including layers of silt, sand, and gravel. Fill, composed of silt and sand, was encountered at thicknesses up to 10 feet or more in many parts of the site. Bedrock was encountered as shallow as 53 feet below surface. Ground water at the site first occurs in either unconsolidated fluvial sediments or fill. Generally, ground water levels are above the water level in the river. The direction of ground water flow generally is toward the river, with horizontal gradients across the site ranging from one-half foot to about one and one-half feet per 100 feet. Ground water flow rates were estimated to be within a range of 2 feet/year to 200 feet/year.

For purposes of discussion, three areas have been defined:

- o the on-site area (that is, the site itself);
- o the off-site area (except for the Pawtuxet River); and
- o the Pawtuxet River area.

In addition, the on-site area is broken down into:

- o the Production Area;
- o the Waste Water Treatment Area; and
- o the Warwick Area.

Examination of the facility history identified twelve Solid Waste Management Units (SWMUs), two Areas of Concern (AOCs), and two Additional Areas of Investigation (AAOIs). These sixteen units and areas are of three types:

- o locations of former production facilities;
- o waste treatment or waste storage sites; and
- o locations of documented spills.

Past investigations of the relevant media at the SWMUs, AOCs, and AAOIs have found trace metals, organic solvents, and semi-volatile organics. The previous investigations do not provide a complete picture of the extent of the presence of chemicals at the site that might be related to previous manufacturing activity. It was not possible to conclude, based on currently available data, which chemicals detected were site-related, nor which SWMUs, AOCs, and AAOIs require remediation.

Data gaps are identified which require further investigation. The Facility Investigation Work Plan is designed to satisfy these data needs.

## **STRATEGIC PLAN**

Possible remedial actions at the site must be based on an evaluation of potential risks, both current and future. These risks can be properly evaluated only when the site has been characterized more fully. In this proposal, a strategic plan outlines the overall strategy and tactics for collecting and organizing the data needed for implementing the techniques of risk evaluation recommended by current USEPA guidance.

### **Public Health and Environmental Risk Evaluation (PHERE) Work Plan**

The PHERE evaluates the potential human health and environmental risks possibly associated with estimated exposures to chemicals that may be related to former operations of the SWMUs, AOCs, and AAOIs. The PHERE is designed to meet, at a minimum, the following requirements of the Order:



- o identification of any potential sources (e.g., SWMUs) and affected media at the facility;
- o selection of Constituents of Concern;
- o analysis of potential migration pathways for identified Constituents of Concern;
- o estimation of appropriate exposure point concentrations;
- o comparison of exposure point concentrations to appropriate exposure guidelines; and
- o characterization of potential risks.

The PHERE serves to evaluate whether site-related Constituents of Concern found at the SWMUs, AOCs, and AAOIs present a possible risk to public health and the environment.

Analytical and historical data in a background investigation will be evaluated to characterize the SWMUs, AOCs, and AAOIs in terms of the type and quantity of chemicals present in the environmental media (such as soil, ground water, surface water, and river bed sediment).

The migration pathway analyses identify site-specific transport pathways and characterize the media relevant to that transport. The findings are to be used to estimate potential exposure of human and environmental receptors to site-related Constituents of Concern. Potential receptor populations will be identified based on the migration pathway analysis. Exposure scenarios will be developed to estimate the potential exposures for all relevant pathways for human and environmental populations. Estimates of potential daily intake are to be made using actual or estimated exposure point concentrations combined with the various exposure scenarios.

The risk characterization includes an evaluation of potential carcinogenic and noncarcinogenic health impacts. Evaluation of potential health effects includes the estimation of the excess incremental cancer risk and the characterization of both the long-term and short-term effects from exposure to noncarcinogenic compounds. The potential for adverse effects to the environment are estimated for the various media and related receptors using exposure point concentrations. Interpretations of the estimated risks associated with potential exposures are presented.

#### **Media Protection Standards (MPS) Work Plan**

Media Protection Standards are used to establish guidelines for measuring the necessity for and/or the degree of protection afforded by the corrective measures considered in the Corrective Measures Study. The identified MPS consist of applicable or relevant and appropriate (state and/or federal) requirements (ARARs). MPS are developed for those Constituents of Concern that do not have an appropriate established criteria or for which an Alternative Concentration Limit is proposed. The development of these MPS follows the guidance given in the USEPA Guidance for Establishing Target Cleanup Levels for Soils at Hazardous Waste Sites and other related guidance documents, as needed.

#### **Corrective Measures Risk Evaluation Work Plan**

The Corrective Measures Risk Evaluation assesses each potentially applicable corrective measure based on the extent to which it mitigates both short- and long-term potential human health and environmental risks. Mitigation will be evaluated based on reduction of residual chemical concentrations and protection of human health both during and after implementation of the corrective measure. The evaluation will also include assessment of environmental impacts of each corrective measure.

The information collected about possible chemical releases, routes of exposure, and human and environmental exposure points will be used as input for further development of the proposed corrective measures, along with consideration of the MPS. Each corrective measure will be compared to the MPS in accordance with current USEPA guidance. The methodology and site-specific models employed will be analogous to those used in the PHERE.

### **Project Management Plan**

The Project Management Plan identifies the project organization and the required tasks to be accomplished while conducting the RFI. Organization of this project provides for a Project Coordinator who is an employee of CIBA-GEIGY and who will be responsible for the interactions with USEPA. The Project Coordinator will be responsible for overseeing of work identified in the Order. CIBA-GEIGY will use consultants to assist in the conduct of the RCRA Facility Investigation. Consultants will conduct the field investigation, evaluate the analytical data, perform the Public Health and Environmental Risk Evaluation, propose the Media Protection Standards, and prepare the Corrective Measures Study, under the district supervision of CIBA-GEIGY.

### **FACILITY INVESTIGATION WORK PLAN**

Field studies will be accomplished in two phases. Phase I will consist of two rounds of field investigation, sampling, and monitoring of selected environmental media to identify any remedial actions required. The Phase I Interim Report will be submitted at the same time as the Phase II proposal. The purpose of Phase I is to identify the presence of any environmental concerns related to CIBA-GEIGY activities. The purpose of Phase II is to determine and verify the extent of site-related chemicals in environmental media, and to collect other data needed to conduct the Corrective Measures Study. Selected environmental monitoring will begin in Phase I and continue uninterrupted until the RFI Report. Review of the Phase II proposal will not stop field data collection.

## **Physical Characterization**

Geophysical investigations will be undertaken to characterize subsurface conditions beneath the facility. Surveys will be conducted using ground penetrating radar, seismic refraction, and electrical resistivity techniques.

Geologic studies will be performed to characterize potential migration pathways. This will be done through literature review, field mapping, and the physical-geological investigation. Hydrogeologic investigations will be performed principally to characterize the uppermost aquifer. Data will be gathered on ground water flow paths and gradients, daily and seasonal variations in ground water flow, aquifer types and boundaries, hydraulic conductivities, and stratigraphic units. Investigations include surficial soil samples, soil borings, and monitoring wells and piezometers. New wells and piezometers will be installed, both shallow and deep. Existing wells and piezometers will be used to supplement and add more detail to the hydrogeologic characterization. Justification for each well and measurement is detailed in the work plan.

## **Release Characterization**

Environmental media will be sampled to characterize possible releases from ten SWMUs, one AOC, the two AAOIs, the Pawtuxet River, and the off-site area. Table 1 shows the numbers of samples to be collected from each medium and the analyses to be performed on each sample. Each SWMU or area is described here, together with the reason for selecting the impacted media for sampling.

**SWMU-1: Hazardous Waste Storage Area.** The hazardous waste storage area is located on the Warwick side of the river in the northeastern corner of the property, and was used for storing 55-gallon drums of hazardous waste. Closure of this unit was approved by the Rhode Island Department of Environmental Management (RIDEM) in 1987. Because there are no known releases from this area, investigation of this SWMU is not required by the Order.

**SWMU-2: Hazardous Waste Storage Tank.** SWMU-2 was a 6000-gallon steel tank located in the tank farm adjacent to both the railroad tracks and Building 14. The tank typically contained process waste, mainly solvents. Closure of this unit was approved by the RIDEM in 1987. No releases from SWMU-2 are known or suspected. However, soil samples taken downslope of SWMU-2 contained organic chemicals. Soils and ground water from this area will be sampled to determine the nature, concentration, and extent of migration of compounds, if any, released from SWMU-2.

**SWMU-3: Hazardous Waste Storage Tank.** SWMU-3 was a 7500-gallon above ground steel tank located in the same tank farm as SWMU-2. This tank was used to store flammable liquids for periods of less than 90 days. Closure of this unit was approved by the RIDEM in 1987. Because soils downslope from the tank farm were found to contain low concentrations of organic chemicals, soils and ground water will be sampled to determine if a possible release came from the tank farm or from AOC-13.

**SWMU-4: Trash Compactor Station.** The trash compactor station was located in the Production Area, north of Building 27. No releases were known to occur from this unit. Investigation of SWMU-4 is not required by the Order.

**SWMU-5: River Sediment Storage Area.** SWMU-5 consists of sediments dredged from the Pawtuxet River, stockpiled in the Warwick area of the facility, and brought to grade in 1977. Soil samples from SWMU-5 contained volatile and semi-volatile organics. Soils and ground water from this area will be sampled to determine if site-related Constituents of Concern have migrated or been displaced and if ground water has been impacted.

**SWMU-6: Zinc Oxide/Soil Pile.** SWMU-6 is a zinc oxide/soil pile located in the Warwick area. The zinc oxide residue was from an incident involving a broken railcar. Analysis of soil samples from SWMU-6 contained elevated levels of zinc

(24,600 ppm). Soil samples will be taken in the area of SWMU-6 to determine the extent to which site-related Constituents of Concern may have migrated.

**SWMU-7: Chlorosulfonic Acid Spill Area.** Approximately 500 gallons of chlorosulfonic acid were spilled over an area about 10 feet by 20 feet. Soils within the spill area were neutralized and subsequently excavated to accommodate new tank farm foundations in the Production Area. Soil borings will be taken from this area to determine if site-related Constituents of Concern have migrated.

**SWMU-8: Prussian Blue Spill Area.** Blue-stained soil was excavated in 1961 to construct the foundation for the new tank farm. No information exists regarding the release at SWMU-8. The soil is believed to be from a possible Prussian Blue spill. About 300 cubic yards of that soil were excavated and subsequently removed. Soil samples and ground water samples will be taken to determine if all of the impacted soils have been excavated and if site-related Constituents of Concern have migrated into ground water.

**SWMU-9: Waste Water Pipeline Break.** A break in the main raw waste transfer line (on the Warwick property) resulted in the discharge of about 24,000 gallons of waste water to the soil and the Pawtuxet River. Soil, surface water, and sediment will be investigated to determine if site-related Constituents of Concern have migrated and if the Pawtuxet River has been impacted.

**SWMU-10: Waste Water Pipeline Break.** A break in an underground waste water line in the Waste Water Treatment Area resulted in the discharge of about 24,000 gallons of waste water to the soil and the Pawtuxet River. Trace concentrations of both volatile and semi-volatile compounds were measured in soil and ground water samples from SWMU-10. Soil and ground water samples will be taken to determine the nature and extent of site-related Constituents of Concern released from the pipeline break. Surface water and sediments samples will be taken from the Pawtuxet River and from a pond located in the northeast corner of

the Waste Water Treatment Area to determine if either of these bodies of water have been impacted.

**SWMU-11: Toluene Waste Water Release.** The ground water samples taken under Building 11, a facility production building, contained low concentrations (less than 1 ppm) of toluene. The building had a subsurface sump that functioned as an overflow reservoir. CIBA-GEIGY estimated that the toluene loss was between 9 pounds and 90 pounds, based on normal building flow conditions and the probable concentrations of toluene in the waste stream. The ground water downgradient from SWMU-11 contained volatile organic compounds. Downgradient subsurface soil samples contained volatile organic compounds and PAHs. Soil and ground water samples will be taken to determine the nature, concentration, and extent of all impacted soils and to determine if the site-related Constituents of Concern have migrated from the release area.

**SWMU-12: Waste Water Treatment Area.** SWMU-12 consists of the area formerly occupied by the waste water treatment plant. Releases of waste water from the treatment facility occurred periodically, including discharges that exceeded the NPDES permit requirements. Discharges exceeding the permitted maximum have been reported for zinc, BOD, and phenols. For two releases, compounds not authorized by the NPDES permit (eg, chloroform) were discharged to the river. Soil samples from SWMU-12 contained trace amounts of volatile and semi-volatile organic compounds. Ground water samples collected in the area contained volatile and semi-volatile compounds. Soil and ground water samples will be collected to determine the nature, concentration, and extent that site-related Constituents of Concern may have been released from SWMU-12. Surface water and sediment samples will be collected to determine if the Pawtuxet River has been impacted by SWMU-12.

**AOC-13: Process Building Area.** Most of the chemical manufacturing operations were located in the southern half of the Production Area on the Cranston side of the river. Soil and ground water samples will be taken to

determine if site-related Constituents of Concern released during facility manufacturing operations, if any, still remain in the surficial soils and/or infiltrated to deeper soil horizons or ground water.

**AOC-14: Atlantic Tubing and Rubber Company Property.** CIBA-GEIGY purchased property adjoining the site in Cranston, Rhode Island from the Atlantic Tubing and Rubber Company. All buildings on the property have been razed and CIBA-GEIGY has not used or redeveloped the land. CIBA-GEIGY has no records of the hazardous waste usage/management activities conducted by the Atlantic Tubing and Rubber Company. The Order does not require investigation of this AOC; thus, no samples will be taken.

**AAOC-15: Laboratory Building Waste Water Sump.** AAOC-15 is a waste water sump located in the northern end of former Building 20. Soil and ground water samples will be taken to determine if site-related Constituents of Concern were released from the waste water sump.

**AAOC-16: Maintenance Department Cleaning Area.** The maintenance department cleaning area was located near the southwest corner of former Building 23. Production machinery (such as portable filters) were brought to this area and steam cleaned. Rinse water was not collected and probably drained to the nearby surface water catch basin. Soil and ground water samples will be taken to determine if site-related Constituents of Concern were released during steam cleaning activities.

#### **Source Characterization**

The wastes (or hazardous constituents) that may have been released, and the physical units that contained those wastes (or constituents) are characterized.



## **Preliminary Phase II Proposal**

A preliminary proposal for the work in Phase II as consistent with the elements detailed in the Order is presented. In Phase II, additional site characterization tasks will be performed to provide the information needed both for the final RFI Report and to develop the Media Protection Standards.

## **QUALITY ASSURANCE DOCUMENTS**

The proposal includes two quality assurance documents. The Data Collection Quality Assurance Plan describes procedures for ensuring that field data are accurate, usable, and traceable. The Analytical Services Quality Assurance Project Plan describes procedures for analytical chemistry and names the specific chemicals to be analyzed that are unique to the operation of the former facility (fingerprint chemicals).

## **HEALTH AND SAFETY GUIDELINES**

The Health and Safety Guidelines describe procedures to be followed for the protection of project personnel, project contractors, USEPA personnel and contractors, and the general public.

## **ORGANIZATION OF THIS DOCUMENT**

This document is organized in three volumes:

- o Volume 1 contains the Current Assessment Summary Report (Chapter 1), the Strategic Plan (Chapter 2), and the Facility Investigation Work Plan (Chapter 3).
- o Volume 2 contains the Quality Assurance Documents (Chapter 4) in two parts -- the Data Collection Quality Assurance Plan (Part A) and the

Analytical Services Quality Assurance Plan (Part B) -- as well as appendices appropriate to the Quality Assurance Documents.

- o Volume 3 contains the Health and Safety Guidelines (Chapter 5).

Each of the five chapters is divided into sections. When reading this document, please note the following:

- o Terms, acronyms, and abbreviations are defined after the Executive Summary.
- o A table of contents follows the terms, acronyms, and abbreviations.
- o Lists of tables and figures follow the table of contents.
- o The figures in this document reflect the best information about the facility and its environs that was available.
- o Tables and figures are numbered within each chapter. This means that Section 3 in Chapter 1 and Section 3 in Chapter 2 may both have a Table 3-1 and/or a Figure 3-1.
- o Tables and figures appear following the text for a chapter. Tables appear first; some tables have multiple pages. Figures appear after the tables.
- o Within each chapter, appendices or attachments, if any, appear last.

TABLE ES-1  
PROPOSED PHASE 1B RELEASE CHARACTERIZATION SAMPLING SUMMARY  
CIBA - GEIGY  
CRANSTON, RHODE ISLAND

UNIT	MEDIA					PARAMETERS				
	SOIL	GROUND WATER	SURFACE WATER	SEDIMENT		APPENDIX A	FINGERPRINT COMPOUNDS	MAJOR IONS	TREATABILITY	TARGET COMPOUNDS
SWMU1	NR	NR	NR	NR						
SWMU2	3 3	2 2	NR	NR						
SWMU3 <sup>(1)</sup>	3 3	2 2	NR	NR						
SWMU4	NR	NR	NR	NR						
SWMU5	5 5	3 3	NR	NR						
SWMU6	1 6	NR	NR	NR						
SWMU7	2 2	1 1	NR	NR						
SWMU8	2 2	2 2	NR	NR						
SWMU9	3 3	NR	*	*						
SWMU10 <sup>(2)</sup>	3 3	4 4	1 1	2 2						
SWMU11	2 2	1 1	NR	NR						
SWMU12	4 4	4 4	*	*						
AOC13 <sup>(3)</sup>	1 1	15 15	NR	NR						
AOC14	NR	NR	NR	NR						
AOC15	1 2	2 2	NR	NR						
AOC16	1 2	2 2	NR	NR						
OFF-SITE	0 14	NR	NR	NR						
BACKGROUND OFF-SITE	4 4	NR	NR	NR						
RIVER	NR	NR	7 7	9						

**NOTES:**

(1). SURFACE WATER AND SEDIMENT SAMPLES WILL BE COLLECTED FROM THE POND LOCATED IN THE WASTE WATER TREATMENT AREA.

(2). SAMPLES ARE COMMON TO SWMU2, SWMU3, SWMU7, SWMU8, AND SWMU11.

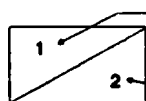
TBD - BACKGROUND SAMPLING LOCATIONS FOR SURFACE WATER, SEDIMENT, AND GROUND WATER WILL BE DETERMINED IN CONSULTATION WITH EPA

**LEGEND:**

SOIL GROUND WATER   
SEDIMENT SURFACE WATER   
SHADED AREAS INDICATE MEDIA OF CONCERN TO BE INVESTIGATED

NR - NOT REQUIRED

\* - ADDRESSED IN THE RIVER SECTION



NUMBER OF SAMPLES COLLECTED IN ROUND 1  
NUMBER OF SAMPLES COLLECTED IN ROUND 2

## RCRA FACILITY INVESTIGATION PROPOSAL TERMS, ACRONYMS, AND ABBREVIATIONS

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In order to improve the clarity of this RCRA Facility Investigation Proposal, certain terms, acronyms, and abbreviations used in the Proposal are explained here. Some terms, acronyms, and abbreviations are used routinely by the USEPA; others are unique to this Proposal.

### General Terms

- o **Environmental media** include soil, ground water, surface water, sediment, and air.
- o **Environmental setting** includes geography, climate, geology, hydrogeology, and hydrology.
- o **Facility boundaries** define that portion of the land owned by CIBA-GEIGY which encompasses all of the plant operating units. The facility boundary is within the legal boundaries of the property.
- o **Fingerprint compounds** are major chemical compounds which were manufactured at the facility and which have been selected on the basis of volume and duration of production, toxicity, and environmental mobility.
- o **Indicator chemicals** are selected accordance with the Superfund Public Health Evaluation Manual (USEPA, 1986), based on their toxicity, persistence, and mobility. Testing of soil and water samples can focus on these compounds as an efficient way of assessing overall environmental quality.

**RCRA FACILITY INVESTIGATION PROPOSAL  
TERMS, ACRONYMS, AND ABBREVIATIONS  
(Continued)**

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- o **Preliminary Investigation** is not part of the RCRA corrective action program but was conducted by CIBA-GEIGY to understand site conditions better.
- o **Release Characterization** is a characterization of the nature and extent of chemical releases to environmental media.
- o **Subsurface soil sample** is a soil sample retrieved from depths greater than 1 foot below ground surface.
- o **Surficial soil sample** is a soil sample retrieved from depths up to 1 foot below ground surface.

**Acronyms**

- o **AAOI --** Additional Area of Investigation.
- o **ACL --** Alternate Concentration Limit.
- o **AEI --** Average Exposed Individual.
- o **AIC --** Acceptable Intake for Chronic Exposure.
- o **AOC --** Area of Concern.
- o **ARAR --** Applicable or Relevant and Appropriate Regulations.
- o **BTEX --** Benzene, Toluene, Ethylbenzene, Xylene.

- o BTX -- See BTEX.
- o CAG -- Carcinogenic Assessment Group.
- o CERCLA -- Comprehensive Environmental Responsibility,  
Compensation and Liability Act.
- o CMS -- Corrective Measures Study.
- o EPA -- See USEPA.
- o HHEM -- Human Health Evaluation Manual.
- o HI -- Hazard Index.
- o IT -- International Technology, Inc.
- o LOAEL -- lowest-observable-adverse-effect level.
- o MCL -- Maximum Contaminant Level.
- o MPS -- Media Protection Standards.
- o NOAEL -- no-observable-adverse-effect level.
- o ORTF -- Over the River Tank Farm.

**RCRA FACILITY INVESTIGATION PROPOSAL  
TERMS, ACRONYMS, AND ABBREVIATIONS  
(Continued)**

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- o **PHERE --** Public Health and Environmental Risk Evaluation.  
(The PHERE is also referred to as the Risk Evaluation.)
- o **POTW --** Publically owned treatment works.
- o **RCRA --** Resource Conservation and Recovery Act.
- o **RFA --** RCRA Facility Assessment. (The RFA is also referred to as the Facility Assessment.)
- o **RfD --** reference dose.
- o **RFI --** RCRA Facility Investigation. (The RFI is also referred to as the Facility Investigation.)
- o **RIDEM --** Rhode Island Department of Environmental Management.
- o **RMEI --** reasonable maximum exposed individual.
- o **SWMU --** Solid Waste Management Unit.
- o **UCL --** upper confidence limit.
- o **USEPA --** United States Environmental Protection Agency.
- o **WCC --** Woodward-Clyde Consultants.

## Abbreviations

- o CIBA-GEIGY -- the CIBA-GEIGY Corporation.
- o Facility or site -- the CIBA-GEIGY facility in Cranston, Rhode Island.
- o Facility Investigation  
Proposal or RFI Proposal - RCRA Facility Investigation Proposal.
- o Order -- Consent Agreement and Order (RCRA Docket No. I-88-1088).

## Terms Defined in the Order

- o "Act" or "RCRA" means the Resource Conservation and Recovery Act, as amended by the Hazardous and Solid Waste Amendments of 1984, 42 U.S. C. §§ 6901 et seq.
- o "Appendix IX" means Appendix IX to 40 C.F.R. Part 264 as amended. See 52 Fed. Reg. 25942 (July 9, 1987) (Final Rule).
- o "Area of Concern" means an area at which releases of hazardous waste or hazardous constituents are identified.
- o "Background" for any particular media (ground water, soil, surface water and sediments, and/or air) shall mean a representative nearby sample of that media that is up-gradient of any zone(s) of contamination and is not affected by the Facility.
- o "Director" means the Director of the Waste Management Division for the EPA Region I or his designee.



- o "Facility" includes all contiguous land and structures, other appurtenances and improvements on the land, not limited to solid or hazardous waste management areas used for treating, storing or disposing of hazardous waste.
- o "Ground water" means water below the land surface in the subsurface zone below which all space is filled with water (The saturated zone).
- o "Hazardous Constituents" include those constituents listed in Appendix VIII to 40 C.F. R. Part 261 and Appendix IX to 40 C.F.R. Part 264.
- o "Hazardous Waste" shall be used as defined in § 1004(5) of RCRA, 42 U.S. C. § 6903(5).
- o "Health Based Criteria" shall refer to those health based standards that, in order of preference, have been either promulgated by EPA in regulation form, adopted by EPA in guidance form, or approved by the Director.
- o "HSWA" means the Hazardous and Solid Waste Amendments of 1984.
- o "Monitoring Well" means a well capable of producing ground water samples that, upon laboratory analysis, can provide a reliable indication of ground water quality.
- o "Observation Well" means a well used to measure water table elevations.
- o "Piezometer" means a small diameter, non-pumping well used to measure hydraulic head at some depth below the water table.
- o "Point of Exposure" means the point at which it is assumed a potential receptor can come into contact, either now or in the future with

hazardous waste and/or hazardous constituents.

- o "Release" includes any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment.
- o A "Solid Waste Management Unit (SWMU)" is any unit at a facility which contains or contained solid or hazardous wastes, from which hazardous waste or hazardous constituents might migrate, irrespective of whether the unit was intended for the management of solid and/or hazardous wastes. A solid waste management unit may include areas at facilities which have become contaminated as a result of routine releases of hazardous waste or hazardous constituents. Examples of SWMUs include but are not limited to: landfills, surface impoundments, waste piles, land treatment units, incinerators, injection wells, tanks (including 90-day accumulation tanks), container storage areas, transfer stations, and waste recycling operations.
- o "Uppermost Aquifer" means the geological formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer.
- o "Water Quality Standards" are provisions of State or Federal law which consist of a designated use or uses for the waters of the United States and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the Act.

- o "Zone of Contamination" means the three dimensional extent of contamination that was produced or is being produced form a release of hazardous waste or hazardous constituents from solid waste management units and/or areas of concern. This zone includes solid waste management units and areas of concern and their associated contamination.

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## **Chapter One**

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CURRENT ASSESSMENT SUMMARY REPORT

SECTION 1  
INTRODUCTION

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This Current Assessment Summary Report summarizes information pertinent to the RCRA Facility Investigation (also called the Facility Investigation or the RFI) of the CIBA-GEIGY facility in Cranston, Rhode Island (i.e., the facility or the site). It includes information on: the environmental setting (Section 2); the facility history (Section 3); the RCRA investigation history (Section 4); the Solid Waste Management Units, Areas of Concern, and Additional Areas of Investigation (Section 5). This chapter also includes a discussion of analytical data (Section 6) that served as a preliminary release characterization, and presents conclusions and recommendations (Section 7).

The information presented in this Current Assessment Summary Report is based on a literature review, contacts with personnel, site reconnaissance, the RCRA Facility Assessment, and a Preliminary Investigation conducted by CIBA-GEIGY. The literature review involved contacting state and federal agencies, as well as reviewing CIBA-GEIGY files to identify and interpret data pertinent to the Facility Investigation. In addition, governmental agency and CIBA-GEIGY personnel were asked for personal knowledge relevant to the Facility Investigation. The sources contacted and the nature of the information and publications provided by them are summarized in Table 1-1 at the end of this chapter. Although reconnaissance was conducted as part of the Preliminary Investigation, site reconnaissance also was conducted as part of this Current Assessment Summary Report.

The next section describes the environmental setting of the facility.

**VOLUME I - CHAPTER 1**  
**CURRENT ASSESSMENT SUMMARY REPORT**

**SECTION 2**  
**ENVIRONMENTAL SETTING**

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This section describes the environmental setting of the facility and its environs, including the geography, climate, geology, hydrogeology, and hydrology. Tables and figures for the environmental setting are included at the end of this chapter.

**2.1 GEOGRAPHIC SETTING**

The facility is located along the north and south banks of the Pawtuxet River in Cranston (Providence County) and Warwick (Kent County) Rhode Island (Figure 2-1). The universal coordinates of latitude and longitude for the approximate center of the facility are 41 degrees, 46 minutes, 5 seconds north latitude and 71 degrees, 24 minutes, 43 seconds west longitude (United States Geological Survey, 1975). The equivalent Rhode Island Plane Coordinate System latitude and longitude are approximately easting 524,200 feet and northing 249,000 feet. The defined area of the facility is about 31 acres -- 13 acres north of the Pawtuxet River in Cranston and 18 acres south of the river in Warwick.

Based on the location of known or suspected releases, the geographic setting, and the former plant layout, the facility has been divided into three on-site study areas: the Production Area, the Waste Water Treatment Area, and the Warwick Area. The facility boundaries for each on-site area are shown on the appropriate figures included in this document. Because investigations also will be conducted outside the facility boundaries, two additional study areas have been defined: the off-site area and the Pawtuxet River area.

Surrounding land use is shown on Figure 2-2. Generally, the facility is bordered to the north and south by residential areas, to the east by commercial areas, and to the west by both an open space area (formerly the property of the Atlantic Tubing and Rubber Company) and a mixed industrial area. This mixed industrial area had been used by the Atlantic Tubing and Rubber Company for manufacturing rubber and plastic, including polyvinyl chloride.

Property lines (legal boundaries) and on-site buildings also are shown on Figure 2-2. Above-ground utilities, underground utilities, and easements are shown on Figures 2-3A and 2-3B. One right-of-way exists on-site and is shown on Figure 2-3B. This 25-foot wide City of Cranston right-of-way runs through both the Production Area and the Waste Water Treatment Area. Table 2-1 presents all the known utilities located within the City of Cranston right-of-way.

According to Bierschenk (1959), 14 borings or test wells were drilled on-site. It is not known if any of the test wells were converted into supply wells, but no active water supply wells are believed to exist on-site currently. Ground water is not known to be withdrawn from the facility. Seven test wells or supply wells are listed as being drilled within one-half mile of the facility. Three of those wells, two on the Atlantic Tubing and Rubber Company property and one about 2000 feet northwest of the facility (near Fenner Pond), were abandoned prior to 1959. The other four wells were not abandoned as of 1959. One of those four wells, believed to be about 300 feet deep, is located roughly 300 feet east of the Waste Water Treatment Area and just north of the Warwick Avenue bridge. The three other wells, reported to be 12 to 22 feet deep, are located at least a quarter mile from the facility. It is not known if any of these wells are still in use.

Surficial features of the facility are shown on Figure 2-4. Topography, waterways, wetlands, and flood plains are shown on Figure 2-5. The facility is relatively flat with gentle slopes toward the Pawtuxet River. The facility elevation ranges from about 10 to 25 feet above mean sea level. The residential area to the north of the Waste Water Treatment Area occupies an elevated



terrace which is approximately 35 feet above mean sea level. A major waterway, the Pawtuxet River, flows from west to east through the site. Bellefont Pond lies to the west and northwest of the Production Area. The pond drains to the south by means of a stream which flows through culverts for much of its length. That stream enters the Pawtuxet River from the north about 300 feet upstream of the Production Area. Wetlands have not been identified on site but two wetlands areas are adjacent to the site: the Pawtuxet River and Bellefont Pond (U.S. Fish & Wildlife Service, 1975). The Pawtuxet River is designated as R2OW, indicating a free flowing river (open water, lower perennial riverine system). Bellefont Pond is designated as POW, indicating a marsh with standing water (open water palustrine system). Adjacent to the northern section of Bellefont Pond is a wetland designated as PFO1, indicating woods with damp soils (broad-leaved deciduous forested palustrine system).

Some sections of the facility are within the 100-year flood plain (Federal Emergency Management Agency, 1982 and 1984). The entire Warwick Area and about half of the Waste Water Treatment Area are within the 100-year flood plain. About 10 percent of the Production Area along the river is within the 100-year flood plain.

## 2.2 CLIMATIC SETTING

The climate of the facility is greatly influenced by Narragansett Bay and the Atlantic Ocean. Based on a 30-year period of record (1959-1988), the mean annual temperature at Providence is 50.5°F. Providence is located about 4 miles north of the facility. January is the coldest month with a mean temperature of 28.9°F; July is the hottest with a mean of 72.8°F. During this 30-year period, the lowest temperature recorded was -13°F in January 1976; the highest was 104°F in August 1975 (National Oceanic and Atmospheric Administration, 1988).

The annual precipitation during the same 30-year period averaged 41.8 inches of equivalent rainfall (ranging from 25.4 to 67.5 inches). Measurable precipitation

occurs on about one day out of every three, and is distributed fairly evenly throughout the year. There is no defined dry season, but droughts occur occasionally (NOAA, 1988).

The annual snowfall during this 30-year period averaged 36.1 inches. Snowfall has been recorded as early as October and as late as May. January and February receive the greatest amount of snowfall -- 10.0 inches and 9.8 inches, respectively (NOAA, 1988). (Snowfall is included in the precipitation totals given in the preceding paragraph.)

An all-conditions wind rose for the T.F. Green Airport in Warwick appears in Figure 2-6. Based on a 30-year period of record (1948 to 1978), the predominant wind direction was from the northwest, accounting for 8.7% of all winds. By comparison, only 1.2% of all winds were from the east-southeast. Calm conditions (winds up to 3 mph) accounted for 10.2% of all winds (NOAA, 1988).

## 2.3 GEOLOGIC SETTING

The geologic setting of the facility is discussed in terms of regional, local, and site-specific geology. The discussions of regional and local geology are based on published literature; the discussion of site-specific geology is based on geotechnical and hydrogeologic investigations conducted at the facility.

### 2.3.1 Regional Geology

The site is located in the southwestern portion of the geologic province known as the Narragansett Basin. This synclinal basin is partly fault-bounded and extends from southeastern Rhode Island northward into Massachusetts. Rocks in the basin are from the Carboniferous period (about 300 million years ago) and consist of continental clastic sediments that include primarily conglomerates, sandstones, and shales. Those rocks were multiply deformed and moderately metamorphosed during the Permian period (about 250 million years ago). Most of

the rocks of the northern and eastern parts of the Narragansett Basin are moderately metamorphosed. Proceeding southward, the rocks are progressively more metamorphosed and display both textural and mineralogic change (Quinn, 1959).

The southern portions of the basin underwent the most intense deformation during the Permian period. This deformation resulted in major tight isoclinal to recumbent north-to-northeast trending folds and numerous north-to-northwest trending faults (Barosh and Hermes, 1981).

The Narragansett Basin overlies Precambrian formations of the Blackstone series. Rocks associated with the Blackstone series are exposed several miles northwest of the facility. Those rocks, which make up the Avalon terrain, are high-grade metaigneous and metasedimentary rocks that were emplaced and subsequently metamorphosed during the late Precambrian period (about 600 million years ago).

Overburden in the region consists primarily of glacial outwash that includes layers of silt, sand, and gravel (Moulthrop, 1956). Several morphological land forms are present, such as kame terraces, kame plains, kames, and ice channel fillings (Smith, 1956). The outwash forms thick deposits (up to 280 feet) in most lowland areas. In some highland areas outwash is not present (Bierschenk, 1959). The Pawtuxet River flows along the boundary between the Providence outwash plain to the north and the Warwick outwash plain to the south (Figure 2-7).

Typically, the glacial outwash in the region is underlain (at depths ranging from 40 to 280 feet) by the consolidated sedimentary rocks of the Rhode Island Formation, a unit that is widespread in the Narragansett Basin (Figure 2-8). The Rhode Island Formation reaches a maximum thickness of about 10,000 feet (Bierschenk, 1959). That formation generally consists of conglomerates, sandstones, shales, and minor coal seams (Skehan and Murray, 1980).

### 2.3.2 Local Geology

The unconsolidated deposits in the vicinity of the site generally have thicknesses that range from 50 to 100 feet (Bierschenk, 1959). The typical stratigraphy in areas near the facility, as described by Bierschenk (1959), consists of a layer of fill that is underlain by a layer of sand and gravel of variable thickness, which in turn is underlain by a layer of silt. Surface exposures of the Rhode Island Formation do not occur near the CIBA-GEIGY facility.

Scattered pockets of recent alluvial deposits occur in areas east of the site. Those deposits consist of stratified clays, silts, sand, and gravels which typically represent outwash material that was reworked by the Pawtuxet River (Moulthrop, 1956). West of the site, small isolated pockets of material having a high organic content occur adjacent to the Pawtuxet River. Those deposits are found in low, marshy areas where the water table is near the ground surface. The underlying soils, however, are generally similar to the typical outwash found in surrounding areas (Moulthrop, 1956).

### 2.3.3 Facility Geology

Information on the geology of the facility was obtained during the Preliminary Investigation conducted by CIBA-GEIGY. Additional geologic information was obtained from geotechnical investigation data on file with CIBA-GEIGY and the Rhode Island Department of Transportation, and from ground water resources data published by the United States Geological Survey.

#### Preliminary Investigation Data

Site-specific information about the type, thickness, and continuity of the subsurface deposits was obtained using conventional boring techniques. Soil borings logged during the advancement of boreholes for piezometer and monitoring well installation were used to interpret the local stratigraphy. Boring

logs from the Preliminary Investigation are presented in Appendix A (at the end of this chapter). The subsurface strata encountered during drilling were fill and three units of unconsolidated deposits (silt, silty sand, and sand; clayey silt and silty clay; and till).

**Fill.** Fill is composed of silt and fine-to-medium sand with fragments of wood, brick, concrete, fiberglass, and reworked soils. In the Production Area, coal fragments were observed on the surface. Fill up to 12.5 feet thick is located in the southern section of the Production Area adjacent to the bulkhead. Fill thicknesses up to 10 feet were encountered in the Waste Water Treatment Area.

**Unconsolidated Deposits.** Unconsolidated deposits consist of three units:

- o Silt, Silty Sand, and Sand contains occasional peat lenses and was generally encountered below the fill. The thickness and lateral continuity of this unit is variable and could not be quantified from the existing boring data.
- o Clayey Silt and Silty Clay is believed to have been deposited at the same time as the silt, silty sand, and sand unit. The thickness and lateral continuity of this unit is variable and could not be quantified from the existing boring data. It is believed that this unit represents different facies deposited by glaciofluvial and fluvial processes, including reworking by the Pawtuxet River.
- o Till is a dense unit consisting of clay, silt, sand, and gravel was encountered below the clayey silt and silty clay unit in one boring (P-14D; see Appendix A) located in the northern section of the Production Area. In that boring, a till thickness of 11.5 feet was encountered before the boring was terminated. Regional data (i.e., not from the Preliminary Investigation) suggest that this till mantles the underlying bedrock, but the lateral continuity of the till beneath the site has not been investigated.

Although bedrock was not encountered in any of the Preliminary Investigation borings, the other file and published data indicate that bedrock (the Rhode Island Formation) occurs beneath the facility at depths ranging from about 53 feet to 108 feet below ground surface. Bedrock was not encountered at a depth of 120 feet in one boring advanced in the Warwick Area. Beneath the Warwick Avenue bridge (located about 300 feet east of the facility), bedrock occurs about 83 feet below ground surface.

#### File and Published Data

Geotechnical data from previous site investigations (available from CIBA-GEIGY files) were reviewed as part of this study. Specifically, data from geotechnical borings taken in two areas of the facility (the Production Area and the Waste Water Treatment Area) were examined and correlated with data from borings made during the Preliminary Investigation.

Within the northern section of the Production Area, 13 soil borings (ranging in depth from 51 to 73.5 feet) were drilled during 1955 and 1959. Although some variations of the thickness, depth, and color of the subsurface materials were observed, consistent stratigraphic classifications were found within this section of the site. Till up to 14 feet thick was encountered in some of the borings. Bedrock was encountered in two borings at depths of 53 feet and 58 feet below ground surface.

Within the southern section of the Production Area, 17 boring logs were reviewed from borings advanced in 1955, 1956, and 1958. Good stratigraphic correlation was found between those boring logs and the Preliminary Investigation boring logs. Bedrock was encountered in two of the borings at depths of 52.5 feet and 56 feet below ground surface.

In the Waste Water Treatment Area, boring logs for 16 geotechnical borings drilled in 1969 and for one boring drilled in 1970 were reviewed and correlated with soil borings from the Preliminary Investigation. The 1969 borings ranged in depth from 30 feet to 31.5 feet below ground surface. The 1970 boring was terminated at 60.5 feet when bedrock was encountered. In general, the boring data provided good correlation of the local stratigraphy, but minor variations in the color, thickness, and depth of the subsurface materials were observed.

Logs of test borings advanced at and near the facility in 1953 and 1955 (documented by Bierschenk, 1959) also were reviewed. The soil descriptions in those boring logs used terminology which was not consistent with the descriptions in the Preliminary Investigation boring logs. Therefore, detailed comparisons could not be made. However, bedrock was encountered at depths ranging from 53 feet to 108 feet below ground surface. Bedrock was encountered at the following depths: 53 feet and 65 feet in two borings advanced in the Production Area; 100 feet in one boring advanced on the Atlantic Tubing and Rubber Company property; 88 feet in one boring advanced east of the Waste Water Treatment Area but west of Warwick Avenue; 82 feet and 108 feet in two borings advanced in the Warwick Area. Bedrock was not encountered in one boring advanced in the Warwick Area at its completion 120 feet below ground surface.

Logs of test borings advanced at the location of the Warwick Avenue bridge (about 300 feet east of the facility) were obtained from the Rhode Island Department of Transportation. Those logs indicate that bedrock occurs about 83 feet below ground surface.

### Geologic Cross-Sections

Cross-sections of the facility geology are presented as Figures 2-9 and 2-10. Those cross-sections are based primarily on data from the Preliminary Investigation. The locations of the geologic cross-sections are shown on Figure 2-11.

Based on the stratigraphic correlation between the two cross-sections, the (upper) silt, silty sand, and sand unit appears to be thicker and more coarse-grained (predominantly sand) in the Production Area than in the Warwick and Waste Water Treatment areas. Despite the differences in lithology and thickness, the inferred rates of ground water movement are relatively equal among the three areas (Section 2.4). However, differences in transmissivity and yield can be anticipated between the areas due to the differences in thickness.

The clayey silt and silty clay unit appears to be continuous beneath the Waste Water Treatment and Warwick areas. However, in the Production Area that unit is discontinuous, apparently pinching out to the south. The lateral continuity between the two units is not known. Till, encountered in the Production Area, apparently pinches out to the south. Till is believed to mantle the underlying bedrock in the site vicinity, but its occurrence and lateral continuity on-site is not well documented.

## 2.4 HYDROGEOLOGIC SETTING

Locally, ground water occurs in unconsolidated fluvial and glaciofluvial sediments, and in the underlying consolidated sedimentary, metamorphic, and igneous rocks. The fluvial deposits are thin and discontinuous, and would not yield adequate water volumes to wells. The glaciofluvial sediments vary from moderate-to-high yield (75 to 1600 gallons per minute, or gpm) outwash deposits to poor yield (generally less than 2 gpm) till deposits (Bierschenk, 1959). The outwash deposits afford most of the water currently pumped and potentially available. The yield of consolidated rocks is variable depending on such factors as the fracture/joint density and size and the interconnection of fractures/joints. However, the nature and thickness of overlying deposits appears to influence the yield of the consolidated rocks.



The average yields of bedrock wells in the Narragansett Basin are as follows (Bierschenk, 1959): about 40 gpm for 12 wells overlain by less than 25 feet of saturated outwash; about 80 gpm for 37 wells overlain by 25 to 100 feet of saturated outwash; and about 94 gpm for 32 wells overlain by 100 to 180 feet of saturated outwash. Since bedrock was encountered beneath the facility at depths ranging from about 53 to 108 feet, yields averaging 80 gpm may be available from bedrock beneath the facility. However, bedrock overlain by till is expected to yield significantly less water.

Ground water flow in the unconsolidated deposits tends to follow topography; ultimately, the ground water discharges to creeks, rivers, and bays. The hydraulic relationship at the facility between the unconsolidated deposits and the underlying consolidated rocks is not yet well understood. Typically, limited communication occurs between the two units, and water in the unconsolidated deposits may recharge the underlying consolidated rocks.

Ground water flow in consolidated rock is complicated and depends on fracture/joint orientation, size, and density. Taken together, ground water flow in unconsolidated deposits and consolidated rocks can be viewed as having three components: (1) shallow flow, ultimately discharging to local streams, (2) intermediate flow, ultimately discharging to regional streams, and (3) deep flow, ultimately discharging to global base level (i.e., either Narragansett Bay or the ocean).

The depth to water in consolidated rock wells reflects the land surface topography. The water level appears to have little relation to the depth at which the water-bearing fractures/joints are encountered, suggesting that there is an interconnection between the unconsolidated deposits and the underlying consolidated rocks.

Generally, ground water levels are above stream levels, indicating that streams such as the Pawtuxet River are gaining streams (Bierschenk, 1959). Along

most reaches of their courses, gaining streams are being fed by ground water and can maintain base flow during periods of little or no rainfall.

Ground water underneath the facility occurs in fill material as well as in the natural unconsolidated deposits and consolidated rocks. Data on ground water features of the site were collected and interpreted as part of the Preliminary Investigation. Most of these data are based on shallow (less than 20 feet deep) piezometers and monitoring wells that are screened across the lower fill and the upper natural unconsolidated deposits. Three deep (40 to 50 feet) piezometers and one deep monitoring well, screened across lower to intermediate elevations within the unconsolidated deposits, also provided hydrogeologic data. Piezometer and monitoring well construction details are presented in Appendix A and are summarized in Table 2-2. Ground water elevations are presented in Table 2-3. Piezometer and monitoring well locations are shown on Figure 2-12.

Ground water contour maps (Figures 2-13 and 2-14) were constructed based on two synoptic measurements of ground water elevations. The inferred direction of ground water flow is toward the river. Horizontal gradients across the facility range from 0.005 to 0.016 (i.e., a vertical decline or slope varying from 0.5 feet to 1.6 feet across a horizontal distance of 100 feet). The average horizontal gradient for the Production Area is about 0.005 based on the change in ground water elevation in the northern section of the area. (Ground water levels in the southern section of the Production Area are elevated due to the bulkhead -- discussed later -- along the Pawtuxet River; those levels were not used to calculate gradient.) The average horizontal gradients for the Waste Water Treatment Area and the Warwick Area are about 0.016 and 0.010, respectively.

The rates of ground water movement were inferred based on permeability data from published information on sands and silty sands, on the horizontal gradients, and on an assumed porosity of 0.3. The inferred rates are: 2 to 180 feet per year for the Production Area; 6 to 190 feet per year for the Waste Water Treatment Area; and 4 to 120 feet per year for the Warwick Area. Tests to

measure ground water flow rates conducted during the Preliminary Investigation were unsuccessful. Therefore, there are no site-specific field measurements to support values calculated from the literature.

Vertical gradients were evaluated based on water level elevations from three nested piezometer pairs: P-14S and P-14D, P-1S and P-1D, and MW-1S and MW-1D. The data indicate that an upward vertical gradient of about 0.4 feet exists between the lower and upper unconsolidated deposits in the northern section of the Production Area. That upward gradient suggests a semi-confined condition in the till and/or bedrock. The data also indicate that an average downward gradient of about 0.9 feet exists between the lower and upper unconsolidated deposits in the southern section of the Production Area. (Vertical gradients, either upward or downward, indicate the potential for flow between units exhibiting different hydraulic heads; the magnitude of flow depends on the nature of the communication between the units.) This downward vertical gradient is not characteristic of ground water conditions in unconsolidated deposits adjacent to a gaining stream, and may be caused by the damming effect created by the bulkhead along the Pawtuxet River.

A cross-sectional diagram of the bulkhead is presented as Figure 2-15. The bulkhead is constructed of sheet steel piling and borders the entire south side of the Production Area. The bulkhead is about 360 feet long and extends about 25 feet below grade. The bulkhead is anchored (by 2-inch steel rods at 10 foot intervals) to an underground concrete beam (dead man). The dead man runs the entire length of the bulkhead. Based on ground water level measurements for P-1S, P-1D, MW-1S, and MW-1D, the bulkhead penetrates about 20 feet into the unconsolidated aquifer.

## 2.5 HYDROLOGIC SETTING

The site is adjacent to, and extends both north and south of, the Pawtuxet River. Thus, it is located within the Pawtuxet River Basin (Figure 2-16). The

basin has a total land area of about 230 square miles (147,200 acres) and is the largest drainage basin in Rhode Island (Metcalf & Eddy, 1983).

The 11.7-mile-long main stem of the Pawtuxet River is formed near River Point in West Warwick by the confluence of the north branch and south branch of the Pawtuxet River. The north branch originates at the outlet of the Situate Reservoir and flows in a southeasterly direction for about 6 miles to the confluence with the south branch. The Situate Reservoir is a water supply reservoir owned and operated by the City of Providence. Releases from the Situate Reservoir depend on the water supply needs of Providence (but a minimum release of 10 million gallons per day is required to maintain base flow).

The south branch originates at the outlet of the Flat River Reservoir. Releases from this reservoir are regulated by the Quidneck Reservoir Company based on downstream water requirements. The south branch flows 9 miles through Coventry and West Warwick before joining the north branch near River Point.

The western portion of the drainage basin is relatively undeveloped. However, the lower reaches of both branches, and especially the main stem of the Pawtuxet River, flow through highly developed residential, industrial, and commercial areas. In addition to the two reservoir dams and the Pawtuxet Cove Dam at the river's mouth, there are small mill dams along both branches and along the main stem of the Pawtuxet River.

There are two USGS gauging stations on the Pawtuxet River: one at Washington on the south branch and one at Cranston on the main stem (Figure 2-15). The one-year-in-ten average seven-day low flow (7Q-10) at the Cranston gauge is approximately 74 cubic feet per second (cfs), which is equivalent to 48 million gallons per day (mgd). That gauge receives the drainage of 200 square miles with a period of record from 1941 to 1985 used to calculate that low flow. A time duration curve for the Cranston gauge discharge from 1941 to 1985 is presented in Figure 2-17. The one-year-in-ten average seven-day low

flow at the Washington gauge is approximately 16 cfs (10 mgd) for the period from 1941 to 1985. The flow measured by that gauge is from a drainage area of 64 square miles. A time duration curve for the Washington gauge discharge from 1941 to 1985 appears in Figure 2-18. Mean monthly discharges for the Pawtuxet River at the Cranston gauge ranged from 75 cfs (in July 1957) to 1788 cfs (in April 1983). Mean monthly discharges for the Pawtuxet River at the Washington gauge ranged from 24 cfs (in August 1974) to 593 cfs (in April 1983). Those data also are based on the period of record from 1941 through 1985 (USGS, 1990).

Sedimentation rates for the main stem of the Pawtuxet River have been estimated based on the occurrence of anthropogenic marker compounds detected in the river sediment. A sedimentation rate of 2.1 centimeters (0.8 inches) per year based on a core taken near the CIBA-GEIGY facility is reported by Avila and Hites (1979). Sedimentation rates of 3.0 centimeters (1.2 inches) per year and 3.4 centimeters (1.3 inches) per year are reported based on sediment cores taken about one mile downstream of the facility (Avila and Hites, 1979).

A sediment core taken about one mile downstream of the facility was used to study sedimentation rates (Quinn et al., 1985). Representative rates for the 1960s were 2.4 to 2.6 centimeters (0.9 to 1.0 inches) per year. Representative rates for the 1970s were 0.6 to 0.9 centimeters (0.2 to 0.4 inches) per year. The apparent change in sedimentation rate may be related to highway construction activities during the 1970s.

The sediment cores analyzed by Avila and Hites (1979) and Quinn et al. (1985) were obtained from areas of fine-grained sedimentation along the channel margin. Therefore, the associated sedimentation rates indicate net sedimentation along the margins. Information about sedimentation rates in the center of the channel was not revealed in the literature review for this report.

Estimating sedimentation rates based on the occurrence of anthropogenic marker compounds in sediment is complicated by several factors including

bioturbation, resuspension, and redeposition. The rates presented above should be viewed as typical deposition rates over the last 20 to 30 years. Variations in these rates occurred by stream position and over time. Human activities (e.g., bridge construction), climatic conditions, and morphologic river changes also contributed to variations in these rates.

The Pawtuxet River has been divided into sections according to water quality standards and classifications established by the Rhode Island Department of Environmental Management (1988). The sections may be classified as freshwater Class A, B, C, D, or E (Figure 2-16). Class A waters are suitable for drinking water supply and all other water uses. Class B waters are suitable for public water supply with appropriate treatment, for agricultural uses, for bathing and other primary contact recreational activities, and for fish and wildlife habitat. Class C waters are suitable for boating and other secondary contact recreational activities, for fish and wildlife habitat, and for industrial processes and cooling. Class D waters are suitable for the migration of fish and have good aesthetic value. Class E denotes nuisance conditions. Class E water use is limited to certain industrial processes, cooling, power generation, and navigation. Classes D and E are used merely to describe existing conditions; they are not considered an acceptable goal for the management of any water course.

The Situate Reservoir and its tributaries are Class A waters. The north branch of the Pawtuxet River, beginning at the outlet of the Situate Reservoir, is Class A; it changes to Class B one-half mile downstream of the dam and maintains that classification to the Fiskeville Dam in Hope. From the Fiskeville Dam to the confluence with the south branch, the north branch is Class C.

The Big River and its tributaries are Class A waters. The Big River flows into the Flat River Reservoir which, along with its tributaries, is Class B. Tributaries of the south branch of the Pawtuxet River are Class B. The south branch becomes Class C just downstream of the Flat River Reservoir Dam and remains Class C to its confluence with the north branch. The main stem of the

Pawtuxet River is Class C, but is considered Class D downstream of the Cranston Sewage Treatment Plant (river mile 4.5). The Meshanticut Brook is Class B. The Pocasset River is mainly Class B, changing to Class C downstream of Print Works Pond. Mashapaug Brook from Spectacle Pond (including Mashapaug Pond and all ponds in Roger Williams Park) to its confluence with the Pawtuxet River is Class C. Spectacle Pond is Class B. Aldrich Brook to its confluence with the Pawtuxet River is Class B.

This section has described the environmental setting of the facility, including its geography, climate, geology (regional, local, and site-specific), hydrogeology, and hydrology. This discussion provides a background for understanding the history of the facility, which is presented in the next section in this Current Assessment Summary Report.

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**SECTION 3**  
**FACILITY HISTORY**

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This section describes the history of the CIBA-GEIGY plant site in Cranston, Rhode Island, (referred to here as the facility). Figures and tables for the facility history are included at the end of this chapter.

The facility was partly occupied by the Alrose Chemical Company from 1930 to 1954. (Currently information on site ownership and use prior to 1930 is not available). In 1954, the Geigy Chemical Company of New York purchased the facility from the Alrose Chemical Company and operated the facility as the new chemical manufacturing plant for the Geigy Chemical Company. Over the years, the plant expanded both its production capacity and its product development capability. Eventually, demand rose beyond the capacity of the plant and production was transferred to other major Geigy Chemical Company facilities.

Between 1954 and 1968, Geigy Chemical Company removed all of the Alrose buildings and constructed a new set of production, warehouse, bulk storage, maintenance, laboratory, and administration facilities. The Warwick property was purchased in 1964 and new vehicular/railroad and pedestrian bridges were built across the Pawtuxet River. Zoning restrictions prevented placing additional production units on the south side of the river. Structures were built to house maintenance and engineering operations, as well as the cafeteria and shower rooms.

In 1970, the Geigy Chemical Company merged with Ciba Corporation of Summit, New Jersey, to form the CIBA-GEIGY Corporation (incorporated in the State of New York). CIBA-GEIGY Corporation is a diversified company that is engaged principally in the discovery, development, manufacturing, and marketing



of a wide variety of special purpose pharmaceuticals and chemical products throughout the United States. After the merger, the Cranston plant was used as a production facility for manufacturing organic chemicals on a batch basis. Since the Geigy Chemical Company began operation at the site, the practice of supplying small volumes of specialized products grew to supplying a vast array of products. Major product categories (and the decades in which they were produced) included:

- 1950s -- agricultural products, and leather and textile auxiliaries
- 1960s -- plastics additives, optical brighteners, pharmaceuticals, and textile auxiliaries
- 1970s -- pharmaceuticals, agricultural products, plastics additives, textile auxiliaries and bacteriostats
- 1980s -- pharmaceuticals and plastics additives

Raw materials and intermediates associated with the facility are listed in Table 3-1. Final products are listed in Table 3-2.

In January 1984, CIBA-GEIGY announced plans for a gradual phase-out of the Cranston plant as part of an overall consolidation of CIBA-GEIGY's chemical manufacturing operations. As of May 1986, CIBA-GEIGY had ceased all chemical manufacturing operations at the facility and began decommissioning and razing the plant. Existing and former structures at the facility are shown on Figure 3-1.

As part of decommissioning and razing the facility, significant environmental and waste management activities were conducted in accordance with (1) the closure plan developed by CIBA-GEIGY and submitted to both the USEPA and the Rhode Island Department of Environmental Management (RIDEM) in the RCRA Part B Permit Application Submission, and (2) the Phase-Down Plan developed by CIBA-GEIGY. Decommissioning included the removal of materials, residues, and wastes, as well as the proper disposal of hazardous wastes. Decommissioning also included cleaning (or otherwise preparing) equipment and structures for removal

and/or demolition. Razing included removing and properly disposing of equipment and fixtures, as well as demolition of buildings. Rubble was disposed of off-site at an approved landfill. Usable equipment was sold.

The decommissioning and razing was performed and inspected by independent contractors and carefully documented. Supporting documentation (including waste manifest forms) was assembled and transmitted to the appropriate regulatory agencies. After reviewing these documents and conducting the final closure inspection, RIDEM determined that the facility has been closed as a storage facility of hazardous waste. That determination was transmitted to CIBA-GEIGY by letter (dated 13 August 1987 from the RIDEM Division of Air and Hazardous Materials).

This section described the history of the CIBA-GEIGY facility, including site ownership, production operations conducted at the site (over time), decommissioning of the site, and certification of facility closure. With this facility history as background, the next section discusses the history of the RCRA program activities (and related investigations) that have been or will be conducted at the site.

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**SECTION 4**  
**RCRA INVESTIGATION HISTORY**

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This section describes the stages of a Resource Conservation and Recovery Act (RCRA) corrective action program in general, and the history of RCRA program activities at the CIBA-GEIGY facility in particular.

**4.1 STAGES OF A CORRECTIVE ACTION PROGRAM**

A RCRA corrective action program applies to operating and closed facilities regulated under Subtitle C (Hazardous Waste Management) of the RCRA, and consists of four stages:

1. RCRA Facility Assessment (RFA);
2. RCRA Facility Investigation (RFI);
3. Corrective Measures Study (CMS); and
4. Corrective Measures Implementation (CMI).

Each of these stages is discussed briefly here.

**4.1.1 RCRA Facility Assessment (RFA)**

The major objectives of the RFA are to:

- o identify and gather information on releases or potential releases;
- o evaluate Solid Waste Management Units (SWMUs), other Areas of Concern (AOCs), and Media of Concern with respect to releases; and

- o make preliminary determinations regarding Constituents of Concern and the need for further investigation and/or action (including interim measures).

Interim measures are designed to mitigate potential or actual releases that could endanger human health and/or the environment. The need for interim measures is evaluated during the entire corrective action program.

#### **4.1.2 RCRA Facility Investigation (RFI)**

The RFI characterizes the impact of known and/or potential releases that were determined to require further action during the RFA. The RFI identifies the types and concentrations of hazardous waste or hazardous constituents released, the rate and direction at which the releases are migrating, and the distances over which the releases have migrated.

The RFI includes the Public Health and Environmental Risk Evaluation (PHERE). The PHERE is designed to identify the human populations and environmental systems that may be impacted by Constituents of Concern associated with the facility. Media Protection Standards (MPS) are then established for the Media of Concern -- those media (e.g., soil, air, water) that may have been impacted by the Constituents of Concern. The MPS are based on applicable promulgated and non-promulgated requirements, standards, and criteria, including health criteria evaluated in the PHERE, background levels, and Alternate Concentration Limits (ACLs). The difference between the Media Protection Standards and the existing conditions at the facility defines the magnitude of the problems at the facility.

#### **4.1.3 Corrective Measures Study (CMS) Proposal**

In the CMS Proposal, corrective measures will be proposed to achieve the Media Protection Standards. Information generated during the RFI will be used to determine the need for corrective measures and to aid in selecting and

implementing those measures. The proposal will justify the selection of the corrective measures that are recommended for study.

#### **4.1.4 Corrective Measures Implementation (CMI)**

The CMS Report will include an investigation and assessment of the proposed corrective measures to meet the proposed Media Protection Standards. The corrective measures are evaluated based on effectiveness, reliability, ease of implementation, timeliness, and protectiveness of human health and the environment. Reports will be submitted to the USEPA and RIDEM periodically throughout the CMS.

## **4.2 HISTORY OF STUDY ACTIVITIES**

The USEPA conducted the RCRA Facility Assessment (RFA) of the CIBA-GEIGY facility in 1987, including the RFA preliminary review, a site reconnaissance, and a sampling visit. Data collected by these tasks were used to make initial determinations about releases and/or potential releases from SWMUs and AOCs, and their potential impact on Media of Concern. The results of the the RFA appear in the "Final RFA Report, CIBA-GEIGY, RCRA Facility Assessment" (dated 20 January 1988). This document is on file with the USEPA and CIBA-GEIGY; the RFA is summarized in Section 6 of this Current Assessment Summary Report.

CIBA-GEIGY conducted its own Preliminary Investigation of the facility in 1988. A Preliminary Investigation is not part of the RCRA corrective action program and, in fact, is unique to this investigation. Work plans prepared for the Preliminary Investigation were submitted to the USEPA for review prior to implementing the work. However, because the Preliminary Investigation is not part of a RCRA corrective action program, the USEPA did not formally review and approve the CIBA-GEIGY work plan. The Preliminary Investigation was designed to provide environmental setting and release characterization information needed to negotiate a comprehensive and site-specific Administrative

Order on Consent for the RCRA Facility Investigation. The Preliminary Investigation included borings, soil sampling, and analysis of water samples from piezometer and monitoring well installations. The Preliminary Investigation data are on file with CIBA-GEIGY and are summarized in Sections 2 and 6 of this Current Assessment Summary Report.

In summary, one stage of the RCRA corrective action program -- the RFA -- has been completed. A supplementary investigation (i.e., the Preliminary Investigation) also has been completed. Those investigations produced most of the data currently available about the facility. Based on the data collected and evaluated for the facility as part of the RCRA Facility Assessment and the Preliminary Investigation, it is currently believed that interim measures are not required.

On 30 September 1988, a draft Administrative Order on Consent (No. I-88-1088) was issued to CIBA-GEIGY by the USEPA. After several negotiating sessions and the evaluation of public comments, the final Administrative Order on Consent was issued by USEPA. That Order was signed by CIBA-GEIGY on 9 June 1989 and became effective on 16 June 1989.

This section reviewed the four stages of an RCRA corrective action program -- the Facility Assessment (RFA), Facility Investigation (RFI), Corrective Measures Study (CMS), and Corrective Measures Implementation (CMI). It also reviewed the history of RCRA program activities at the CIBA-GEIGY facility in particular. The RFA was conducted in 1987; CIBA-GEIGY conducted a Preliminary Investigation in 1988. This RCRA Investigation History, along with the facility history presented in Section 3, provides a background for the next section -- a review of the SWMUs, AOCs, and AAOIs at the facility.

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**SECTION 5**  
**SOLID WASTE MANAGEMENT UNITS, AREAS OF CONCERN,**  
**AND ADDITIONAL AREAS OF INVESTIGATION**

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This section describes the Solid Waste Management Units (SWMUs), Areas of Concern (AOCs), and Additional Areas of Investigation (AAOIs) at the CIBA-GEIGY facility in Cranston, Rhode Island. Figures and tables for the SWMUs, AOCs, and AAOIs are included at the end of this chapter.

Based on information submitted by CIBA-GEIGY to the USEPA and information gathered by the USEPA (including the Facility Assessment), twelve SWMUs and two AOCs have been identified at the facility. In the context of the Facility Investigation, a SWMU is any unit which contained solid or hazardous wastes from which hazardous wastes or a hazardous constituents could have migrated. SWMUs include media (e.g., soil) into which known or suspected hazardous wastes or constituents could have migrated. An AOC is an area at which a release of hazardous waste or a hazardous constituent has been identified. Information about the facility's SWMUs and AOCs is presented here and summarized in Table 5-1. The locations of the SWMUs and AOCs, and the media to be investigated for each, are shown on Figure 5-1.

CIBA-GEIGY has identified two Additional Areas of Investigation (AAOIs) for completeness of study. No releases from those AAOIs are known but the potential for a past release may have existed. The Additional Areas of Investigation have been designated AAOI-15 (the Laboratory Building Waste Water Sump) and AAOI-16 (the Maintenance Department Cleaning Area). Information on the AAOIs also is presented here, summarized in Table 5-1, and shown on Figure 5-1.

CIBA-GEIGY ceased all chemical manufacturing operations in May 1986 when the plant was closed. The plant closure included the removal of materials and residues, as well as the proper disposal of wastes and hazardous wastes. The structures associated with the SWMUs, AOCs, and AAOIs were dismantled. Therefore, with the exception of the mound at SWMU-6 (Zinc Oxide/Soil Storage Pile), there is no physical indication on-site about the nature of the SWMUs, AOCs, and AAOIs.

## **5.1 SOLID WASTE MANAGEMENT UNITS**

Twelve SWMUs have been identified; each is described here.

### **5.1.1 SMWU-1: Hazardous Waste Storage Area**

SWMU-1 was a hazardous waste storage area located on the Warwick side of the river in the northeastern corner of the fenced property (see Figure 5-1). SWMU-1 had a maximum storage capacity of 768 55-gallon drums, and typically stored 300 to 400 drums at any given time. The hazardous waste storage area was asphalt-lined, diked, and surrounded by a 6-foot high chain link fence; it was 42 feet by 58 feet with a 32-inch high concrete containment dike capable of holding 48,000 gallons. The coordinates for the approximate center of SWMU-1 are 248,975 northing and 524,935 easting. (These coordinate values are in feet in the Rhode Island grid system.)

SWMU-1 was used from 1981 through 1986 solely for storing various hazardous wastes in drums (including flammable liquids and solids, corrosive liquids and solids, organic mixtures and solids, non-hazardous organic mixtures, and chloroform). SWMU-1 was decommissioned by OH Materials using the standard operating procedures described in the Storage and Treatment Facility Closure Plan (RCRA Part B Permit Application Submission, 1985). Closure of this unit was verified by a professional engineer from Bechtel National Inc. The closure was approved by the Rhode Island Department of Environmental Management (RIDEM) in 1987.



SWMU-1 was decommissioned prior to the on-site sampling investigation. Media of Concern were not sampled from this unit during either the Facility Assessment or the Preliminary Investigation. No evidence of releases was observed by the USEPA contractors during the Facility Assessment sampling visit. The potential for exposure to any waste previously managed in the unit was considered negligible by the USEPA contractors. There are no known releases from this area. Investigation of this SWMU is not required by the Order.

#### 5.1.2 SWMU-2: 6000-Gallon Hazardous Waste Storage Tank

SWMU-2 was a 6000-gallon hazardous waste storage tank located in the tank farm adjacent to both the railroad tracks and Building 14 in the Production Area (see Figure 5-1). The tank contained liquid hazardous waste mixtures generated at the facility including process waste containing acetone, toluene, monochlorobenzene, isopropanol, naphtha, xylene, heptane, methanol, and water. The carbon steel vertical tank was 8 feet in diameter and 17 feet high; it was supported by a one-foot thick reinforced concrete slab, and was surrounded by a secondary containment dike with a capacity of 8000 gallons. The coordinates for the approximate location of the former hazardous waste storage tank are 249,130 northing and 523,860 easting.

Liquid hazardous wastes were transferred regularly from SWMU-2 to railroad cars for off-site disposal. No releases from SWMU-2 were known or suspected during its period of operation. The hazardous storage waste tank, including the pumps and piping associated with loading the tank cars, was inspected regularly. Drainage from the diked enclosure originally flowed to the facility's waste water treatment plant. However, in compliance with federal hazardous waste storage requirements, this pathway was sealed off; subsequently, water from the sump within the dike was pumped out for disposal.

SWMU-2 was used from 1981 through 1986 (when the facility was decommissioned). Closure of SWMU-2 was performed by OH Materials in 1986 using the standard operating procedures described in the Storage and Treatment Facility Closure Plan (RCRA Part B Permit Application Submission, 1985). Decommissioning of the unit was verified by a professional engineer from Bechtel National, Inc. The closure was approved by RIDEM in 1987.

The media to be investigation for SWMU-2 are soil and ground water.

#### **5.1.3 SWMU-3: 7500-Gallon, 90-Day Accumulation Tank**

SWMU-3 was an above-ground 7500-gallon accumulation tank located in the same tank farm as SWMU-2 (see Figure 5-1). The stainless steel accumulation tank was used to store flammable liquids for periods less than 90 days. The vertical tank was 8.5 feet in diameter and 17 feet high, and was enclosed (along with three other tanks) by a containment dike having a capacity of 25,000 gallons. The coordinates for the approximate location of SWMU-3 are 249,110 northing and 523,890 easting.

The accumulation tank operated during 1985 and 1986 (until the facility was decommissioned). No releases were known or suspected during the period of operation. Liquid wastes from SWMUs-2 and -3 were pumped into a 10,000-gallon railroad car for weekly shipment to an off-site disposal facility. Approximately 260,000 gallons of non-RCRA-regulated wastes were loaded each year.

Closure of SWMU-3 was performed by OH Materials in 1986 using the standard operating procedures described in the Storage and Treatment Facility Closure Plan (RCRA Part B Application Submission, 1985). Decommissioning was verified by a professional engineer from Bechtel National Inc. The closure of SWMU-3 was approved by RIDEM in 1987.

The media to be investigated for SWMU-3 are soil and ground water.

#### **5.1.4 SMWU-4: Trash Compactor Station**

SWMU-4 was a trash compactor station located on a concrete pad (21 by 36 feet) north of Building 27 in the Production Area (see Figure 5-1). Two compactors of 30 and 55 cubic yards' capacity handled packaging material, waste paper, and washed fiber drums. The pad area drained to the on-site waste water treatment plant. The coordinates for the approximate center of the trash compactor station are 249,050 northing and 524,010 easting. The compactors operated from 1972 to 1986 and were in good physical condition during their period of operation.

There were no known releases from this area, nor are releases suspected. Any releases from a compactor would have collected at the drainage sump for the pad and then flowed to the waste water treatment plant. Media of Concern were not identified during the Facility Assessment or the Preliminary Investigation and are not identified in the Order.

#### **5.1.5 SWMU-5: River Sediment Storage Area**

SWMU-5 was a storage area for river bed sediment. In 1971, sediment was dredged from the Pawtuxet River from the reach between the Production Area's pedestrian and vehicular bridges. Dredging took place as part of the removal of the original cofferdam/waste water outfall. The sediment was stockpiled in the Warwick Area. Approximately 6630 cubic yards of sediment were stockpiled until December 1976, when the material was removed from the facility. The area was brought back to grade in 1977 as part of the flood plain restoration required under the Wetlands Act to permit construction of the waste water equalization tanks at the CIBA-GEIGY waste water treatment plant. The stockpile occupied an irregularly shaped area. Historical maps and other documents do not provide definitive information on the shape and exact location of SWMU-5. The coordinates for the approximate center of the former sediment pile are 249,020

northing and 525,220 easting. The approximate size of the sediment pile is shown on Figure 5-1.

Since the river sediment stockpile was removed before the plant was decommissioned, decommissioning activities did not affect SWMU-5. However, the potential for a release existed before the sediment stockpile was removed.

The media to be investigated for SWMU-5 are soil and ground water.

#### 5.1.6 SWMU-6: Zinc Oxide/Soil Pile

SWMU-6 is a soil pile containing residues of zinc oxide. In the late 1960s, zinc oxide spilled from a broken rail car containing 140,000 pounds of zinc oxide that was on the siding near Buildings 32 and 33 in the Warwick Area. The spilled zinc oxide was transferred to another rail car. Although most of the spill was cleaned up, some residue remained. Paved areas were swept as part of normal plant maintenance. After the spill, road sweepings from in and around the railroad spur in the Warwick Area contained some zinc oxide residue. Those sweepings were used to form a drainage berm (soil pile) at the current location of SWMU-6 (see Figure 5-1).

The soil pile was not removed during decommissioning activities and remains on-site. The soil pile, approximately 50 feet long by 7 feet wide by 2 feet high, contains about 25 cubic yards of material. Visually, the pile contains about 10 percent zinc oxide and can be identified by the lack of vegetative growth. The coordinates for the approximate center of SWMU-6 are 248,920 northing and 524,615 easting

The medium to be investigated for SWMU-6 is soil.

#### **5.1.7 SWMU-7: Chlorosulfonic Acid Spill Area**

SWMU-7 was an area where, in 1961, approximately 500 gallons of chlorosulfonic acid were spilled from a trailer truck. The spill area was about 10 feet wide by 20 feet long (see Figure 5-1). Soils within the spill area were neutralized and subsequently excavated to accommodate new tank farm foundations in the Production Area. Little more is known about the chlorosulfonic acid release at SWMU-7. For example, it is not known what was used to neutralize the spill or how much soil was removed. The coordinates for the approximate center of SWMU-7 are 249,080 northing and 523,955 easting.

The media to be investigated for SWMU-7 are soil and ground water.

#### **5.1.8 SWMU-8: Prussian Blue Spill Area**

SWMU-8 was an area where Prussian Blue was spilled. Blue-stained soil was excavated in 1961 to construct the foundation for a new tank farm. No information exists regarding the release at SWMU-8. However, it is believed that blue soil was first noticed around 1956. Approximately 300 cubic yards of soil were removed and replaced with new fill for the storage tank foundation. In the 1960s, during the installation of the waste water piping system, another quantity of blue stained soil was excavated just east of Building 24. The quantity of soil excavated is not known. The approximate center of SWMU-8 is 248,975 northing and 523,990 easting.

The media to be investigated for SWMU-8 are soil and ground water.

#### **5.1.9 SWMU-9: Waste Water Pipeline Break — Warwick Area**

SWMU-9 was a break in a waste water pipeline in the Warwick Area. On 12 January 1982, a break in the main raw waste water transfer pipeline (on the Warwick property) leading to the facility's waste water treatment plant resulted

in a discharge to the Pawtuxet River (see Figure 5-1). Remedial measures were taken to reduce flow in the lines and permit repairs. Approximately 24,000 gallons of raw waste water escaped over four hours. The raw waste water entered the surface water runoff catchment system and discharged into the Pawtuxet River via Outfall Number 004. The coordinates for the approximate location of SWMU-9 are 249,010 northing and 524,840 easting.

Laboratory analysis of the material spilled or the media impacted was not performed after the release. The influent to the waste water treatment plant typically contained halogenated and non-halogenated solvents and other organic compounds (e.g., materials routinely used in the chemical manufacturing process). The pH of the discharge varied from 4 to 12. The pH of the river both upstream and downstream of the discharge was measured by CIBA-GEIGY personnel; both readings had a pH of 6. The spill resulted in a period of bypass under the facility's NPDES permit.

The media to be investigated for SWMU-9 are soil, ground water, sediment and surface water.

#### **5.1.10 SWMU-10: Waste Water Pipeline Break — Waste Water Treatment Area**

SWMU-10 was a break in a waste water pipeline in the Waste Water Treatment Area. On 7 September 1983, an underground pipeline feeding one of three equalization tanks ruptured in the Waste Water Treatment Area (see Figure 5-1). Pre-treated neutralized waste water from the equalization tanks normally passed through a clarifier before discharging to the Cranston publically owned treatment works (POTW). The break occurred at a "Y" splice located before the equalization tanks and five feet below the ground surface. About 40,000 gallons of waste water escaped in the 50-minute period before the flow could be shut off. The discharge flowed east around the 1.5 million gallon equalization tank, into a small pond, and then diverted to the Pawtuxet River. The coordinates for the approximate location of SWMU-10 are 249,575 northing and 524,955 easting.

The pH of the released waste water was 8.5; the chemical oxygen demand (COD) was 1010 ppm. This discharge contained acetone (31 pounds), isopropyl alcohol (45 pounds), toluene (7 pounds), xylene (1.7 pounds), zinc (0.25 pounds), and nitrobenzene (0.125 pounds). On the day of the release, surface water samples of the river were collected by RIDEM. Toluene was detected in both the upstream (1.1 ppm) and downstream (2.0 ppm) samples.

The media to be investigated for SWMU-10 are soil, ground water, sediment, and surface water.

#### **5.1.11 SWMU-11: Toluene Waste Water Release**

SWMU-11 was a subsurface sump where toluene was spilled. Building 11, a facility production building, was razed in October 1983 (see Figure 5-1). During demolition, ground water samples taken from beneath the building's sump contained low concentrations (less than 1 ppm) of toluene. The subsurface sump -- SWMU-11 -- was made of concrete, had a capacity of 300 gallons, and functioned as a waste water reservoir. CIBA-GEIGY estimated that the toluene loss was between 9 and 90 pounds (based on normal building flow conditions and the probable concentration of toluene in the waste stream). Toluene was a primary organic solvent used in the facility's manufacturing processes. The coordinates for the approximate location of the Building 11 sump are 248,990 northing and 523,770 easting.

The media to be investigated for SWMU-11 are soil and ground water.

#### **5.1.12 SWMU-12: Waste Water Treatment Plant**

SWMU-12 was a waste water treatment plant (including trickling towers) that was used during facility operations to treat large volumes of waste water and to minimize the environmental impact of water discharged to the Pawtuxet River

(see Figure 5-1). CIBA-GEIGY was issued a NPDES permit (RI 0001171) in 1974 to construct and operate the plant. SWMU-12 began operation in November 1970 and continued through July 1983 under the US Clean Water Act limitations. In July 1983, CIBA-GEIGY was connected to the Cranston POTW. After the tie-in, process water was pre-treated and analyzed before being discharged to the city's POTW. SWMU-12 operated until the facility was decommissioned and razed in 1986.

Releases of waste water from SWMU-12 occurred periodically before the tie-in to the Cranston POTW was complete. Biological trickling towers were used at the facility from 1970 until 1983. Periodic sump overflows from these towers resulted in discharges to the river. Influent to the trickling towers routinely contained volatile and semi-volatile organic compounds. Additional releases from SWMU-12 also have been documented, including discharges that exceeded the NPDES permit requirements. Discharges exceeding the permitted maximum have been reported for zinc, BOD, and phenols. For two releases, compounds not identified in the NPDES permit (e.g., chloroform) were discharged to the river. The coordinates for the approximate center of the trickling tower are 249,405 northing and 525,015 easting.

The media to be investigated for SWMU-12 are soil, ground water, sediment, and surface water.

## 5.2 AREAS OF CONCERN

Two AOCs have been identified and are described here.

### 5.2.1 AOC-13: Process Building Area

Chemical manufacturing took place at the site from 1930 to 1986. Alrose Chemical Company, Geigy Chemical Company, and CIBA-GEIGY Corporation owned and operated chemical manufacturing operations during that time. Only



limited information is available about the operations and processes conducted by Alrose Chemical and Geigy Chemical. Most of the chemical manufacturing operations were located in the southern half of the Production Area (see Figure 5-1). This entire area (which encompasses several SWMUs) has been identified as AOC-13. All of the structures in this area have been razed and much of the area has been regraded.

The media to be investigated for AOC-13 are soil and ground water.

#### **5.2.2 AOC 14: Atlantic Tubing and Rubber Company Property**

In 1981, CIBA-GEIGY purchased 23 acres of property adjoining the site in Cranston, Rhode Island from the Atlantic Tubing and Rubber Company. This property -- AOC-14 -- is located to the west of the Production Area (see Figure 5-1). All buildings on the AOC-14 property have been razed and CIBA-GEIGY has not used or redeveloped the land. CIBA-GEIGY has no records of the hazardous waste usage/management activities conducted by the Atlantic Tubing and Rubber Company. No SWMUs are known at AOC-14. Investigation of AOC-14 is not required by the Order.

### **5.3 ADDITIONAL AREAS OF INVESTIGATION**

Two AAOIs have been identified and are described here.

#### **5.3.1 AAOI-15: Laboratory Waste Water Sump**

AAOI-15 is a waste water sump located in the northern end of former Building 20, a laboratory building (see Figure 5-1). The gravity sump was used during normal operations in the laboratory building, and drained to sanitary sewer lines that discharged to the Cranston POTW. The coordinates for the approximate location of AAOI-15 are 249,695 northing and 523,930 easting.

The media to be investigated for AAOI-15 are soil and ground water.

### **5.3.2 AAOI-16: Maintenance Department Cleaning Area**

AAOI-16 is the maintenance department cleaning area that was located near the southwest corner of former Building 23 (see Figure 5-1). Production machinery (such as portable filters) were brought to this area and steam cleaned. Rinse water was not collected and probably drained to the nearby surface water catch basin. The coordinates for the approximate location of AAOI-16 are 248,570 northing and 524,670 easting.

The media to be investigated for AAOI-16 are soil and ground water.

This section reviewed the twelve SWMUs, the two AOCs, and the two AAOIs at the CIBA-GEIGY facility. The history, physical characteristics, operation and usage, and closure or demolition of every unit or area was described, as well as the nature of wastes pertinent to each. The next section discusses the analytical data available for each of these units or areas.

**VOLUME 1 - CHAPTER 1**  
**CURRENT ASSESSMENT SUMMARY REPORT**  
**SECTION 6**  
**DISCUSSION OF ANALYTICAL DATA**

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This section discusses the analytical data for the facility that were obtained during the Facility Assessment and the Preliminary Investigation. The purpose and objectives of the Facility Assessment were discussed in Section 4. The purpose and objectives of the Preliminary Investigation conducted by CIBA-GEIGY were to: (1) collect and analyze a limited number of on-site soil and ground water samples on a reconnaissance level; (2) verify and augment the sampling and analysis program implemented as part of the Facility Assessment; (3) provide data on the site's hydrogeology; and, (4) to aid in developing a Facility Investigation Proposal. The data used in this proposal are for screening purposes only and are not intended to replace or serve as a comprehensive round as defined in the Order. Tables and figures pertaining to the analytical data are included at the end of this chapter.

#### **6.1 DATA EVALUATION**

The Facility Assessment analytical data from on-site locations, off-site locations, and the Pawtuxet River, are reviewed and presented here. These data were included in the RCRA Facility Assessment Report and summarized in the "Findings of Fact" section in the Order. Therefore, CIBA-GEIGY has assumed that the USEPA believes the data to be representative of site conditions.

CIBA-GEIGY does not propose further validation of the Facility Assessment data or evaluating quality assurance/quality control associated with the Facility Assessment because such work is beyond the scope of the Facility Investigation Proposal. Instead, CIBA-GEIGY offers the following comments regarding the Facility Assessment. A summary of the analytical results generated during the conduct of the Facility Investigation is also provided.

The Facility Assessment, conducted by Versar, Inc., did not document sampling methodologies. Therefore, CIBA-GEIGY could not evaluate this critical step in the sampling and analysis program. CIBA-GEIGY understands that the Facility Assessment monitoring wells and piezometers do not meet RCRA requirements (i.e., they were not drilled and installed with a sand pack, seal, and grout). Instead, they were emplaced in test pit excavations which were then backfilled. Consequently, CIBA-GEIGY views the ground water analytical data from the Facility Assessment as qualitative rather than quantitative, and views the concentrations reported suggesting a range of probable values.

The Preliminary Investigation analytical data were validated according to the methodologies required by the USEPA for contract laboratory programs. Some quality control problems associated with the laboratory were discovered during validation. The Preliminary Investigation analytical data summarized here include only data that have been validated. The data validation is on file with CIBA-GEIGY.

The quality assurance/quality control protocol implemented in the Preliminary Investigation are described in the work plan entitled "Preliminary RCRA Facility Investigation." The work plan is on file with the USEPA and with CIBA-GEIGY. The USEPA did not formally act on that proposal.

## 6.2 FACILITY ASSESSMENT ON-SITE CHARACTERIZATION

On-site sampling and analysis of ground water and soil were conducted as part of the Facility Assessment (Versar, Inc., 1988). Eight ground water samples were analyzed for metals, volatile and semi-volatile organic compounds, and pesticides/PCBs. The results of these analyses are summarized in Table 6-1. The distribution of the ground water samples (using the USEPA sample designations), was as follows:

- o Production Area - GW-1; GW-2; GW-2A; GW-3; GW-4; GW-5;

- o Warwick Area - GW-8; and,
- o Waste Water Treatment Area - GW-6.

The sampling locations are shown on Figure 6-1. The samples were obtained from piezometers installed in backfilled test pit excavations. The piezometers were not installed according to RCRA specifications (which require drilling into undisturbed soil). Nonetheless, the piezometer installations were deemed acceptable by the USEPA for the Facility Assessment sampling. However, because of these installation conditions, the precision of the ground water data from the Facility Assessment is regarded as qualitative rather than quantitative, and the reported concentrations are viewed as suggesting the range of actual values.

Five subsurface soil samples were collected at depths ranging from 1 to 3 feet. All five samples were analyzed for volatile and semi-volatile organics, pesticides, and PCBs. Two of these samples also were analyzed for metals. The USEPA and CIBA-GEIGY conducted their analyses of the soil samples independently. The results of the independent analyses of these split soil samples are summarized in Table 6-2. The sampling locations associated with the Facility Assessment are shown on Figure 6-1. The distribution of soil samples (using the USEPA sample designations) was as follows:

- o Production Area - SS-1; SS-1A; SS-2
- o Warwick Area - SS-3; and
- o Off-site Area - BG-1.

Soil and ground water sampling locations, and summaries of the analytical results from these samples, are shown on Figures 6-2 and 6-3.

### **6.2.1 Production Area**

During the conduct of the Facility Assessment, three soil samples and six ground water samples were collected from the Production Area. The soil samples were analyzed for volatile and semi-volatile organics, pesticides, and PCBs. The ground water samples were analyzed for metals, volatile and semi-volatile organics, pesticides, and PCBs.

Analytical results for the soil samples indicate that low levels (6.4 ppm and 1.7 ppm) of polynuclear aromatic hydrocarbons (PAHs) were detected in SS-1 and SS-1A, respectively. Phthalate esters also were detected at trace concentrations (1.4 ppm and 0.1 ppm) in those samples. All other compounds analyzed either were not detected or were found at concentrations near the method detection limits.

Ground water samples collected from the Production Area contained levels of benzene, toluene, ethylbenzene, and xylene (BTEX) that ranged from not detected (GW-4) to 1342 ppb (GW-2). Detectable levels of chlorinated volatiles ranged from 2 ppb (GW-1) to 1811 ppb (GW-5). Chlorinated volatiles were not detected in GW-4. Metals were detected at or near primary or secondary drinking water standards in most ground water samples. Elevated levels of manganese, zinc, and arsenic were detected in several of the Production Area monitoring wells. Other compounds (such as semi-volatiles, pesticides, and PCBs) were detected at or near the method detection limits.

### **6.2.2 Waste Water Treatment Area**

Only one ground water sample, GW-6, was collected from the Waste Water Treatment Area during the Facility Assessment. Analytical results indicate that no BTEX, semi-volatile organics, pesticides, or PCBs were detected. Except for manganese (5470 ppb), all metals were detected below drinking water standards.

### **6.2.3 Warwick Area**

One soil sample (SS-3) and one ground water sample (GW-8) were collected from the Warwick Area. No detectable levels of BTEX, semi-volatile organics, pesticides, or PCBs were found in the ground water sample. Except for manganese (5360 ppb), metals were detected below drinking water standards. Sample SS-3 contained 3.2 ppm arochlor-1254 (PCB). However, no detectable levels of volatile or semi-volatile organics or pesticides were found. Concentrations of metals were slightly elevated, but were fairly consistent with concentrations typical in urban environments.

## **6.3 PRELIMINARY INVESTIGATION ON-SITE CHARACTERIZATION**

The Preliminary Investigation conducted by CIBA-GEIGY included analysis of soil and ground water samples from the three on-site study areas (i.e., the Production Area, the Waste Water Treatment Area, and the Warwick Area). These samples were analyzed for Targeted Compound List parameters plus a 30-compound library search (i.e., TCL+30). One soil sample and one ground water sample from each of the three on-site study areas was analyzed for Appendix IX parameters. An additional Appendix IX analysis was performed on one surficial soil sample from the Warwick Area. The sampling and analysis program implemented as part of the Preliminary Investigation is summarized in Table 6-3. Five surficial soil samples, nine subsurface soil samples from borings and ten ground water samples from newly installed monitoring wells were collected. Field blank samples and trip blank samples were also analyzed (Tables 6-4 and 6-5, respectively). The sampling locations associated with the Preliminary Investigation are also shown on Figure 6-1.

### **6.3.1 Production Area**

In the Production Area, five soil samples and six ground water samples were collected and analyzed. Most of the buildings in the Production Area have been

razed and the area has been regraded, so only subsurface soil samples were collected. Subsurface soil samples were obtained from borings advanced in order to install the monitoring wells. Generally, those samples were taken from vertical intervals that span the water table. One sample (from monitoring well MW-5S) was taken from just above the water table. Four of the six monitoring wells in the Production Area were installed downgradient of the SWMUs, the AOCs, and the location of the former manufacturing buildings. Those wells are adjacent to the bulkhead along the Pawtuxet River and include MW-1S, MW-1D, MW-2S, and MW-3S. Monitoring well MW-1S is screened across the fill; MW-1D is screened across the lower unconsolidated deposits. MW-2S is screened across the fill; MW-3S is screened across the fill and the upper unconsolidated deposits. Monitoring well MW-4S, installed to investigate soil and ground water quality near SWMU-11, is screened across the fill and the upper unconsolidated deposits. Monitoring well MW-5S, located in the northern section of the Production Area, is an upgradient (background) well which is screened across the upper unconsolidated deposits. The Preliminary Investigation analytical data for the Production Area soil and ground water samples are summarized in Tables 6-6, 6-7, 6-8, 6-9, and 6-10, in Figures 6-2 and 6-3, and are discussed next.

### Soil

**Volatile Organic Compounds.** The highest concentrations of volatile organic compounds (VOCs) were detected in samples MW-1D (58.8 ppm total VOC), and MW-2S (9.5 ppm total VOC) which were located on the northern banks of the Pawtuxet River. The bulk of these totals consisted of BTEX and chlorinated volatiles. Other volatile organic compounds detected in these samples included acetone, which was detected in both samples (MW-1D and MW-2S) at concentrations of 2.9 ppm and 0.064 ppm, respectively. The remaining samples contained less than 0.2 ppm total VOC.

**Semi-Volatile Compounds.** Total semi-volatile concentrations in soil collected from the Production Area ranged from 0.1 ppm (MW-5S) to 85.5 ppm



(MW-1D). Polynuclear aromatic hydrocarbons (PAHs) constituted essentially all the compounds detected in the entire semi-volatile fraction for all the samples analyzed. The highest concentrations were associated with the borings adjacent to the Pawtuxet River (MW-1D and MW-2S). Total concentrations of semi-volatile compounds for samples MW-3S, MW-4S, and MW-5S were less than 5 ppm. Sample MW-2S contained elevated levels (43.7 ppm) of total semi-volatile tentatively identified compounds (TICs). Phenolic compounds constituted essentially all compounds detected in the library search for MW-2S. Sample MW-4S also contained elevated levels of TICs (11.3 ppm). Samples MW-3S and MW-5S contained 4.3 ppm and 2.0 ppm of TICs, respectively.

**Metals.** Concentrations of trace metals (e.g., arsenic, chromium, lead, mercury, selenium) were low and generally consistent with concentrations typical in urban environments. The metals found in Production Area soil samples are summarized in Table 6-10.

**Pesticides/PCBs.** Sample MW-2S contained 3.3 ppm arochlor-1248 (PCB). PCBs were not detected in any other Production Area soil sample. Pesticides were detected in only one sample, MW-1D, at a concentration of 2.6 ppm.

### Ground Water

**Volatile Organic Compounds.** Benzene, toluene, ethylbenzene, and xylene were detected in monitoring well MW-1S (located south of the production facilities) at a total concentration of 9994 ppb. Toluene also was detected in monitoring wells MW-1S, MW-2S, and MW-4S at concentrations of 130 ppb, 4300 ppb and 39,000 ppb, respectively. These three wells also contained significant concentrations of chlorobenzene (ranging from 300 ppb to 33,000 ppb). In addition, MW-2S contained 35,000 ppb of 1,2-dichloroethenes (total). Sample MW-4S also contained 2400 ppb of a chloromethyl benzene isomer. Samples collected near the Pawtuxet River contained relatively high concentrations compared to samples from other Production Area monitoring wells. In samples MW-1D,

MW-3S, and MW-5D, total volatile organic compounds ranged from not detected to 7 ppb.

**Semi-Volatile Compounds.** The acid extractable compounds comprise a significant portion of the semi-volatile compounds detected in samples MW-1S, MW-2S, and MW-4S. The total concentrations of acid extractables ranged from 172 ppb (MW-1S) to 588 ppb (MW-4); none were detected at MW-1D, MW-3S, or MW-5S. Other semi-volatile subfractions detected consisted of PAH compounds, phthalate esters, and dichlorobenzenes. The PAH concentrations ranged from 14 ppb (MW-3S) to 211 ppb (MW-2S); none were detected at MW-1S, MW-1D, or MW-5S. The phthalate esters were detected in all wells; the three highest concentrations were 240 ppb (MW-3S), 170 ppb (MW-5S), and 115 ppb (MW-1S). All of these readings were associated with blank contamination. Dichlorobenzenes (predominantly the 1,2 isomer) were detected at MW-2S (286 ppb) and at MW-4S (51 ppb). Elevated levels of TICs were detected in the library search of all samples except MW-1D; concentrations ranged from 193 ppb to 4812 ppb.

**Metals.** In the Production Area, iron, manganese, and lead concentrations exceeded primary or secondary drinking water standards. Iron concentrations ranged from 4260 ppb (MW-1S) to 71,500 ppb (MW-4S). The secondary drinking water standard for iron was exceeded at all well locations. Manganese concentrations ranged from 445 ppb (MW-2S) to 5050 ppb (MW-1D) with all locations exceeding the secondary drinking water standards. Lead concentrations exceeded the primary standard at well MW-4S (59 ppb) and at MW-2S (192 ppb). All other metals were below drinking water standards in all Production Area monitoring wells.

**Pesticides/PCBs.** Sample MW-5S contained 5.5 ppb chlorodane (pesticide). Pesticides or PCBs were not detected in any other Production Area ground water sample.

### Production Area Summary

Most of the organic Constituents of Concern observed in soil and ground water samples were consistent with the materials used during facility operations. However, PAH concentrations appear to be more consistent with an urban environment. Polynuclear aromatic hydrocarbon levels downgradient (topographically and hydrologically) of the railroad were higher than at any other area on the property. It may be that the ballast used along these lines or creosoted railroad ties at least partially contributed to the levels of PAHs found in soil and ground water samples.

Iron, manganese and lead concentrations exceeded federal primary or secondary drinking water standards at several of the monitoring wells located in the Production Area. However, ground water is not used as a domestic source in the vicinity of the CIBA-GEIGY facility. Further, the metals observed in ground water samples occur naturally and their presence in ground water does not necessarily indicate a release. The presence and concentrations of metals need to be compared to natural background conditions.

Volatile organic constituents detected in soil and ground water samples collected from the Production Area were consistent with the materials used during past facility operations. However, PAH concentrations detected in soil and ground water samples cannot be attributed solely to past facility operations. It is possible that the railroad ties may have partially contributed to the PAH levels detected in soil and ground water samples. Other off-site sources upwind may have also been partially responsible. Another possibility is that spilled solvents may have dissolved macadam sometime in the past. Levels of iron and manganese were detected above the federal primary drinking water standards in all monitoring wells installed in the Production Area.

### 6.3.2 Waste Water Treatment Area

In the Waste Water Treatment Area, three soil and three ground water samples were collected and analyzed. The area has been affected by demolition and regrading activities, so only subsurface soil samples were obtained during the Preliminary Investigation. Two of the soil samples were taken from just above the water table and one soil sample was taken from the vertical interval that spans the water table. Two of the three monitoring wells (MW-7S and MW-8S) serve as downgradient wells and are located adjacent to the Pawtuxet River. One monitoring well, MW-9S, was installed to investigate upgradient conditions associated with SWMU-10, in particular, and with the Waste Water Treatment Area, in general. The Preliminary Investigation analytical data for the Waste Water Treatment Area are summarized in Tables 6-6, 6-9, 6-11, 6-12, and 6-13.

#### Soil

**Volatile Organic Compounds.** In the Waste Water Treatment Area, volatile organic compounds were very low (<1 ppm) or not detected. Toluene, acetone, and total chlorinated volatiles were detected in sample MW-7S at concentrations of 0.003 ppm, 0.015 ppm and 0.027, ppm respectively. Toluene also was detected in sample MW-9S (0.023 ppm), but this sample was associated with blank contamination. At location MW-8S, the only detected VOC was 1,1,1-trichloroethane (0.009 ppm).

**Semi-Volatile Compounds.** Low concentrations (well below 10 ppm) of semi-volatile compounds were found in soil samples. Polynuclear aromatic hydrocarbons were detected at MW-7S (1.50 ppm total PAH) and MW-8S (0.048 ppm total PAH). PAH compounds detected included fluoranthene, phenanthrene, and pyrene. Other semi-volatile compounds detected included phthalate esters, which were detected at MW-8S (0.80 ppm total phthalates) and MW-9S (2.17 ppm total phthalates).

**Metals.** Concentrations of trace metals (e.g., arsenic, chromium, lead, mercury, selenium) were low and generally were consistent with concentrations typical in urban environments. The metals found in Waste Water Treatment Area soil samples are summarized in Table 6-11.

**Pesticides/PCBs.** Pesticides detected in MW-7S included alpha-chlordane, gamma-chlordane, dieldrin, 4,4'-DDE (and its metabolite 4,4'-DDD) at levels of 0.672 ppm, total. No other pesticides or PCBs were detected in the Waste Water Treatment Area soil samples, Octachlorodibenzo-p-dioxin also was detected in MW-7S at 0.22 ppb.

### Ground Water

**Volatile Organic Compounds.** Volatile aromatic compounds (specifically, BTEX compounds, toluene, and xylene) were detected in low concentrations in only the MW-9S sample; the toluene concentration was 3 ppb and the total xylene concentration was 6 ppb. Chlorinated volatile compounds were detected in samples MW-8S, MW-9S, and the MW-9S duplicate (DUP). Methylene chloride was detected at 10,000 ppb in sample MW-8S, at 4 ppb in MW-9S, and at 50 ppb in the MW-9S duplicate. Other chlorinated volatiles detected in MW-8S included 1,2-dichloropropane (83 ppb) and 1,1,1-trichloroethane (470 ppb).

**Semi-Volatiles Compounds.** Semi-volatile organic compounds that were detected were at concentrations below 50 ppb. Polynuclear aromatic hydrocarbons were detected in sample MW-8S at a total concentration of 18 ppb. Bis (2-ethylhexyl) phthalate was detected in all four ground water samples. The concentrations ranged from 2 ppb (MW-9 DUP) to 43 ppb (MW-8S). (Frequently, this compound is a laboratory artifact).

**Metals.** All iron and manganese concentrations exceeded federal secondary drinking water standards. The iron concentrations ranged from 3680 ppb (MW-9S) to 35,800 ppb (MW-8S). The manganese concentrations ranged from 1160 ppb

(MW-7S) to 4100 ppb (MW-8S). Cyanide was not detected in any of the monitoring wells. Chromium concentrations ranged from 11.6 ppb (MW-9S) to 62.4 (MW-8S).

**Pesticides/PCBs.** Neither pesticides nor PCBs were detected in any of the Waste Water Treatment Area ground water sample.

#### Waste Water Treatment Area Summary

A limited environmental characterization was implemented in the Waste Water Treatment Area as part of the Preliminary Investigation. Only three soil samples and three ground water samples were collected in this study. Analytical results for the soil samples indicated that levels of volatile and semi-volatile organic constituents were approximately equal between the boring upgradient (both topographically and hydrologically), MW-9S, and the borings downgradient, MW-7S and MW-8S.

Analytical results for the ground water samples generally displayed a pattern similar to that of the soil sample results. Volatile and semi-volatile organic constituents, except chlorinated volatiles, were detected at approximately the same levels in the upgradient monitoring well (MW-9S) and the downgradient monitoring wells (MW-7S and MW-8S). However, analytical results for metals in the ground water samples do not seem to display a pattern similar to that for volatile and semi-volatile organic constituents. Iron concentrations were detected at higher levels in the downgradient monitoring wells than in the upgradient well. Manganese concentrations were relatively similar in all three monitoring wells.

Soil and ground water collected for the Waste Water Treatment Area displayed very low levels of volatile and semi-volatile organic constituents. Further, the analytical results were similar between the (topographically and hydrologically) upgradient monitoring well and the downgradient monitoring wells, suggesting that the levels detected may be regional and not site-specific. The exception to this is iron, which was detected at higher concentrations downgradient than upgradient.

### 6.3.3 Warwick Area

The eastern section of the Warwick Area has not been affected by demolition activities. Consequently, surficial soil samples were collected to investigate SWMU-5 and SWMU-6. At SWMU-5, four soil samples were collected (one sample per quadrant). At SWMU-6, one soil sample was collected. Additionally, one shallow monitoring well (MW-6S), screened across the upper unconsolidated deposits, was installed at SWMU-5 to evaluate ground water quality. A subsurface soil sample was collected from the soil boring advanced for the installation of MW-6S. The Preliminary Investigation analytical data for the Warwick Area are summarized in Tables 6-6, 6-9, 6-14, 6-15, and 6-16.

#### Soil

**Volatile Organic Compounds.** Volatile organics either were detected in low concentrations (i.e., well below 1 ppm), or were not detected, in soil samples from the Warwick Area. Analysis of the soil from MW-6S detected no VOCs except for 2-butanone, which was detected at 0.003 ppm and was associated with method blank contamination. Ethylbenzene and toluene were the only BTEX compounds detected in soil samples - RS-1, RS-2 and RS-5. Toluene was detected at three locations - RS-1 (0.001 ppm), RS-2 (0.007 ppm), and RS-5 (0.005 ppm) - while ethylbenzene was detected only at location RS-2 (0.001 ppm). Chlorinated volatiles that were detected included methylene chloride (RS-2, RS-3, RS-4), chlorobenzene (RS-5), trichloroethylene (RS-5), and tetrachloroethylene and 1,1,1-trichloroethane (RS-1, RS-2). The highest chlorinated volatile concentration detected was 0.013 ppm for tetrachloroethylene (RS-2). Acetone was detected at a concentration of 0.009 ppm (only at RS-2).

**Semi-Volatile Compounds.** Polynuclear aromatic hydrocarbons were detected at all locations, with total concentrations ranging from 0.2 ppm to 35.5 ppm. The three highest concentrations of PAH compounds were detected in sample RS-2 for

phenanthrene (3.8 ppm), pyrene (6.5 ppm), and fluoranthene (6.5 ppm). The common laboratory contaminant bis (2-ethylhexyl) phthalate was detected in all 1-foot depth samples (RS-1 through RS-5). The concentrations ranged from 0.11 ppm (RS-1) to 0.69 ppm (RS-5). Essentially, all phthalate results were artifacts associated with method blank contamination. Other semi-volatile compounds detected included polychlorinated biphenyl PCB-1254 at concentrations of 0.98 ppm (RS-4) and 2.5 ppm (RS-5). No other semi-volatile organics were detected above 1 ppm. Other reported detections include bis (2-chloroethyl) ether at 0.084 ppm (RS-2) and dibenzofuran at 0.15 ppm (RS-2), 0.1 ppm (RS-3), and 0.014 ppm (RS-4).

**Metals.** Concentrations of trace metals (e.g., arsenic, chromium, lead, mercury, selenium) were low and generally were consistent with concentrations typical in urban environments. The metals found in Warwick Area soil samples are summarized in Table 6-13.

**Pesticides/PCBs.** Arochlor-1254 (PCB) was detected at concentrations of 0.98 ppm and 2.5 ppm in samples RS-4 and RS-5, respectively. PCBs were not detected in any other Warwick Area soil samples. Only samples RS-3 and RS-4 contained detectable levels of pesticides. Chlordane was detected at 0.29 ppm and 0.59 ppm in samples RS-3 and RS-4, respectively.

#### Ground Water

**Volatile Organic Compounds.** Toluene and methylene chloride, frequently laboratory artifacts, were detected at low concentrations (4 ppb and 5 ppb, respectively) at MW-6S. No other volatile organics were detected.

**Semi-Volatile Compounds.** Only traces (<10 ppb) of semi-volatile organic compounds were detected. Semi-volatile compounds that were detected included the pesticide methoxychlor (1.4 ppb) and the phthalate ester bis (2-ethylhexyl) phthalate (2 ppb).



**Metals.** Iron and manganese were detected at 15,000 ppb and 963 ppb, respectively. Both concentrations exceeded federal secondary drinking water standards. Other metals (including chromium, lead, and cyanide) were detected below the drinking water standards.

**Pesticides/PCBs.** Sample MW-6S contained 1.4 ppb methoxychlor (pesticide). No other pesticides or PCBs were detected in sample MW-6S.

### Warwick Area Summary

A limited environmental characterization was implemented in the Warwick Area as part of the Preliminary Investigation. Soil and ground water samples were collected near SWMU-5, the River Sediment Storage Area. Constituents of Concern are limited primarily to semi-volatile compounds (primarily PAHs) in soil samples. Low levels (less than 40 ppb) of volatile organic compounds were detected in the soil samples collected from the Warwick Area. The relative absence of volatile organic compounds near SWMU-5 may be due to the fact that the river sediment pile was allowed to aerate for five years. Volatile organic compounds that may have been present in the pile when it was dredged from the river would be less persistent than semi-volatile organic compounds or inorganic compounds. The PAH compounds detected are common in heavy oils, asphalts, tars, and creosote, and are typical of sediments affected by urban runoff.

Iron and manganese concentrations exceeded federal secondary drinking water standards in monitoring well MW-6S. However, currently ground water is not a source of drinking water, so the drinking water standards should be used only as reference values for comparison.

In general, the environmental characterization conducted in the Warwick Area was a SWMU-specific study. Only traces of volatile organic compounds were detected in soil and ground water samples collected near SWMU-5. Polynuclear

aromatic hydrocarbons were detected in all soil samples, but were not detected in the ground water monitoring wells. PCBs were detected in two soil samples, at concentrations below 5 ppb. Iron and manganese were detected above the federal secondary drinking water standards in the ground water monitoring well. Other metals were detected but only at concentrations below their respective drinking water standards.

#### 6.4 OFF-SITE CHARACTERIZATION

The Rhode Island Department of Environmental Management (RIDEM) conducted surficial soil sampling in the vicinity of the facility on three dates: 23 July 1986, 12 November 1986, and 15 April 1987. The soil analyses included metals, volatile organic compounds, polynuclear aromatic hydrocarbons, phthalates, benzotriazoles, and pesticides. The RIDEM off-site sampling and analysis program is presented and discussed in the Facility Assessment Report. The data from the RIDEM program are considered to be part of the Facility Assessment; the sampling locations are shown in Figure 6-4.

The analytical results of the off-site soil sampling are presented in Tables 6-17, 6-18, and 6-19. Based on those results, RIDEM concluded the following in an internal memorandum dated 21 September 1987.

"It is the conclusion of this study that the sampling indicates there is no widespread contamination of soil by emissions from Ciba Geigy and any contamination present in the area surrounding Ciba Geigy doesn't present a significant health risk."

The USEPA conducted surficial soil sampling in the vicinity of the facility on 19 May 1988. Four samples were collected from Fay Field (located about 0.6 miles northeast of the facility), and two samples were collected from the Park View Junior High School ball field (located about 0.4 miles northwest of the facility). Soil analyses included volatile and semi-volatile organic compounds,

pesticides, and PCBs. The analytical results are on file with the USEPA and CIBA-GEIGY. Analytical results indicate that low levels (approximately 1 ppm, total) of PAHs were detected in two of the samples. PCBs were not detected in any of the samples, and only trace levels (less than 0.1 ppm) of pesticides were detected in five of the samples. Based on the concentrations of the compounds detected, it is unlikely that on-site manufacturing operations have impacted these areas.

A USEPA toxicologist calculated the total potential lifetime cancer risk level associated with the Constituents of Concern observed in the soil samples. Those constituents include PAHs, pesticides, and PCBs. The potential lifetime cancer risk level was calculated to be one in one million. A one in one million cancer risk is a risk defined as one additional potential cancer occurrence per one million persons continually exposed to the Constituents of Concern during their lifetimes. In a letter dated 1 November 1988 to Representative Irving H. Levin regarding this matter, the USEPA stated the following:

"In EPA's opinion this represents an insignificant cancer risk probability of one in one million."

## 6.5 PAWTUXET RIVER CHARACTERIZATION

The literature review conducted as part of the Current Assessment Summary Report found no documentation that water has been sampled from the Pawtuxet River since May 1986 (when chemical manufacturing operations at the facility were terminated), although there are many water quality reports for the Pawtuxet River that pre-date May 1986. Those earlier reports characterize water quality primarily in terms of physical parameters, microbiological and inorganic constituents, and parameters such as chemical oxygen demand (COD), biological oxygen demand (BOD), and dissolved oxygen. Because of the dynamic nature of river flows, past sampling results may not reflect current conditions. The surface water investigation to be conducted as part of the Facility Investigation will address the impact, if any, that site conditions are having on surface water

quality. In cooperation with the USEPA and RIDEM, applicable or relevant and appropriate Media Protection Standards will be identified for the Pawtuxet River. The Media Protection Standards will be proposed at the end of Phase II of the Facility Investigation.

Sediment quality was investigated as part of the Facility Assessment. Four sediment samples were collected from the Pawtuxet River adjacent to the site (see Figure 6-1) and analyzed for metals, volatile and semi-volatile organic compounds, pesticides, and PCBs. Two of those samples also were analyzed for chlorinated dioxins (e.g., tetra chloro dibenzo-p-dioxin, (or TCDD) and furans (e.g., tetra chloro dibenzo furan, (or TCDF). The depths at which the samples were taken are not reported. The analytical data for those samples are presented in Table 6-20. CIBA-GEIGY took splits of these sediment samples, and the analytical data for those splits also are presented in Table 6-20.

Analytical results for metals indicate that the upstream sediment sample (SD-4) generally contained higher concentrations of metals than any of the downstream sediment samples. Relative to other sediment samples, sample SD-4 contained elevated levels of arsenic, barium, cadmium, chromium, iron, lead, mercury, vanadium, and zinc.

Trace levels (less than 0.5 ppm) of toluene were detected in samples SD-1, SD-2, and SD-3. Chlorinated volatiles, primarily methylene chloride, were detected in all samples. However, methylene chloride also was detected in the laboratory blank.

Polynuclear aromatic hydrocarbons were detected in samples SD-1 and SD-4 at concentrations of 6.3 ppm and 33.5 ppm, respectively. Pesticides and PCBs were not detected in any of the sediment samples.

The Pawtuxet River has received industrial discharges since the nineteenth century. During the period when water was the primary source of power, forges

and textile mills discharged to the Pawtuxet River. Privies serving up to 3000 employees were positioned directly over the river. More recently, the river has received discharges from industries and sewage treatment plants.

Some compounds observed in sediment samples from the Pawtuxet River may be attributable to past operations at the facility (e.g., toluene and chlorobenzene). However, many compounds may have been contributed by other upstream sources. Those conditions will be examined as part of the Facility Investigation. The next section presents the conclusions and recommendations of this Current Assessment Summary Report.

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**CURRENT ASSESSMENT SUMMARY REPORT**  
**SECTION 7**  
**CONCLUSIONS AND RECOMMENDATIONS**

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This section presents the conclusions and recommendations from the Current Assessment Summary Report. These conclusions and recommendations are based on the environmental setting of the facility (discussed in Section 2), the facility history (discussed in Section 3), the RCRA investigation history (discussed in Section 4), the nature and characteristics of the SWMUs, AOCs, and AAOs (discussed in Section 5), and the analytical data currently available regarding the facility (discussed in Section 6).

**7.1 CONCLUSIONS OF THE CURRENT ASSESSMENT SUMMARY REPORT**

The Current Assessment Summary Report draws the following conclusions:

1. Information on site ownership, activities, and land use prior to 1930 is not available.
2. The RCRA Part B permit for the facility, issued in response to CIBA-GEIGY's 1985 application, did not require ground water monitoring because the type of hazardous waste management activities did not warrant monitoring.
3. Additional characterization of the facility is necessary to determine the need for and type of potential corrective measures.
4. Additional physical characterization of the facility is necessary to understand the geologic, hydrogeologic, and hydrologic conditions in detail.

5. The physical characteristics of the Pawtuxet River relative to the RCRA Facility Investigation have not been investigated.
6. The type, amount, and quality of information available from the RCRA Facility Assessment and the Preliminary Investigation do not provide a complete description of the environmental conditions of the site.
7. Existing data on the environmental setting adequately describe the geography, climate, and both the regional geology and hydrology. The data on the local geology, hydrogeology, and hydrology are insufficient to define the corrective actions that may be necessary. Facility geology and hydrogeology are more complete but require additional detail.
8. Release characterization has not been conducted for most SWMUs and AOCs, nor for any AAOIs. The release characterization data that exist for some of the SWMUs and AOCs are inadequate.

## 7.2 RECOMMENDATIONS FOR FURTHER RFI WORK

The Current Assessment Summary Report makes the following recommendations about data needed regarding site history, geology, hydrogeology, hydrology, and release characterization.

### 7.2.1 Site History Data Needs

1. If feasible, more information on site ownership and use prior to 1930 will be obtained. The pre-1930 site use may provide insight into the nature and occurrence of Constituents of Concern identified in environmental media.

### 7.2.2 Geologic Data Needs

1. The apparent difference in stratigraphy between the Production Area and Waste Water Treatment Area needs to be defined better. That difference will be evaluated in terms of ground water flow.
2. The occurrence of potential semi-confining strata will be investigated.
3. Continuous sample test borings will be advanced to define the facility stratigraphy in more detail. The nature and thickness of the overburden, the occurrence of till, and the depth to (and rock quality of) bedrock will be evaluated.

### 7.2.3 Hydrogeologic Data Needs

1. Additional piezometers and monitoring wells will be installed in the overburden to quantify ground water flow.
2. Some piezometers will be field tested for hydraulic conductivity.
3. Bedrock piezometers/monitoring wells will be installed to evaluate ground water flow at depth.
4. The communication between the unconsolidated deposits and bedrock will be evaluated.
5. The effect of the bulkhead on ground water flow will be characterized.
6. Vertical gradients will be evaluated.
7. Ground water use, if any, within the site vicinity will be determined. If wells exist, then their locations, depths, and production rates will be determined.



#### **7.2.4     Hydrologic Data Needs**

1. Bathymetric, stream flow, and sediment discharge data will be collected.
2. Upstream and downstream conditions will be quantified.

#### **7.2.5     Release Characterization Data Needs**

1. The nature and extent of releases will be investigated further.
2. Releases also will be characterized in terms of hazardous classification.
3. After the SWMUs, AOCs, and AAOIs have been characterized adequately, the potential impacts of the releases on human health and the environment will be evaluated.
4. Soil samples will be collected to delineate releases, if present in the unsaturated zone.
5. Ground water will be collected from wells to delineate releases in the saturated zone.

References cited in this Current Assessment Summary Report are given in the next section.

### **7.3 INVESTIGATION STRATEGY FOR SATISFYING DATA NEEDS**

The conclusions and recommendations of this Current Assessment Summary Report provide the basis for defining the investigative strategies that will be used to satisfy the various data needs. These strategies are discussed in Chapter 2 -- the Strategic Plan. The Strategic Plan contains:

- o the Public Health and Environmental Risk Evaluation (PHERE) work plan;
- o the Media Protection Standards (MPS) work plan;
- o the Corrective Measures Risk Evaluation work plan; and
- o the Project Management Plan.

Based on the Strategic Plan, the Facility Investigation Work Plan (Chapter 3) can be presented.

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SECTION 8  
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## **Tables**

TABLE 1-1

SUMMARY OF DATA SOURCES AND DATA OBTAINED FOR THE CURRENT ASSESSMENT SUMMARY REPORT  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Information Source	Publication* and/or Type of Information
United States Environmental Protection Agency	<ul style="list-style-type: none"> <li>• Draft Consent Orders</li> <li>• RCRA Facility Assessment (obtained through CIBA-GEIGY)</li> <li>• Surficial soil sampling results</li> <li>• Public meeting notes and general public submissions</li> </ul>
United States Geological Survey	<ul style="list-style-type: none"> <li>• Quadrangle maps depicting topography, surficial geology, and bedrock geology</li> <li>• "Ground Water Resources of the Providence Quadrangle Rhode Island" (1959)</li> <li>• Pawtuxet River discharge data</li> </ul>
United States Fish and Wildlife Service	<ul style="list-style-type: none"> <li>• National Wetlands Inventory Map: Providence Quadrangle (obtained through Statewide Planning Program office)</li> </ul>
Federal Emergency Management Agency	<ul style="list-style-type: none"> <li>• Flood Insurance Rate Maps (obtained through Statewide Planning Program office)</li> </ul>
National Oceanic and Atmospheric Administration	<ul style="list-style-type: none"> <li>• Climatic Data: temperature, precipitation, snowfall, wind</li> </ul>
Rhode Island Department of Environmental Management: Division of Water Resources	<ul style="list-style-type: none"> <li>• "Water Quality Regulations for Water Pollution Control" (1988)</li> <li>• "A Study of the Water Quality of the Pawtuxet River: Chemical Monitoring and Computer Modeling of Pollutants - Volume I: Chemical Monitoring of Pollutants In the Pawtuxet River" (1985)</li> <li>• "Pawtuxet River Basin Water Quality Management Plan" (1977)</li> <li>• Well Survey</li> </ul>

TABLE 1-1 (continued)

SUMMARY OF DATA SOURCES AND DATA OBTAINED FOR THE CURRENT ASSESSMENT SUMMARY REPORT  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Information Source	Publication* and/or Type of Information
Rhode Island Department of Administration Statewide Planning Program	<ul style="list-style-type: none"> <li>• "Pawtuxet River, Rhode Island: Use Attainability Study" (1983)</li> <li>• "Pawtuxet River Basin: Non-Point Water Quality Standards Review and Management Plan" (1987)</li> <li>• Flood Insurance Rate Maps for Cranston (1984) and Warwick (1982) Rhode Island</li> </ul>
City of Cranston Tax Assessor's Office	<ul style="list-style-type: none"> <li>• Historic site ownership</li> </ul>
Rhode Island Department of Transportation: Division of Public Works	<ul style="list-style-type: none"> <li>• Boring logs associated with the reconstruction of the Warwick Avenue Bridge</li> </ul>
GEOD Corporation	<ul style="list-style-type: none"> <li>• Base maps for the facility and surrounding area generated using photogrammetric techniques and aerial photographs taken during April 1989. (Most of the maps presented here were produced using the GEOD base maps.)</li> </ul>
CIBA-GEIGY Corporation	<ul style="list-style-type: none"> <li>• "RCRA Part B Permit Application Submission" (1985)</li> <li>• "Final RFA Report CIBA-GEIGY RCRA Facility Assessment" (1988)</li> <li>• "Organic Compounds in an Industrial Wastewater: A Case Study of their Environmental Impact (1979)</li> <li>• Boring logs associated with proposed on-site construction activities</li> <li>• Maps depicting property lines, easements, plant layout, surrounding land use, waterways, and floodplains</li> <li>• Data from the Preliminary Investigation</li> <li>• Historic maps showing utilities, rights-of-way, and the river bulkhead line specifications</li> </ul>

\* See Section 8 for a complete list of references in this chapter.



**TABLE 2-1**  
**UTILITIES LOCATED WITHIN THE CITY OF CRANSTON RIGHT-OF-WAY**  
**CIBA-GEIGY FACILITY**  
**CRANSTON, RHODE ISLAND**

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Water Supply:	8-inch
	10-inch Fire Protection
	10-inch
	12-inch
Force Mains:	4-inch Sanitary
	24-inch
Storm Drain:	30-inch
Abandoned Pipe:	36-inch
High Voltage Distribution system	
Low Voltage Distribution System	
Communications System Between Buildings	

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Source: CIBA-GEIGY Corporation file.

TABLE 2-2  
SUMMARY OF PIEZOMETER AND MONITORING WELL CONSTRUCTION DETAILS  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Well Number	Month/Year of Installation	Elevation Data		Boring Data		Monitoring Well/Piezometer Data					Strata Monitored
		Ground Surface	Top of Riser Pipe	Depth	Bottom Elevation	Bottom of Monitoring Zone		Top of Monitoring Zone		Length of Screen	
						Depth	Elevation	Depth	Elevation		
P-1S	4/88	13.73	16.48	10.0	3.7	10.0	3.7	7.0	6.7	3	Fill
P-1D	4/88	13.73	16.38	49.5	-35.8	43.0	-29.3	40.0	-26.3	3	UD
P-2S	4/88	12.78	14.71	11.0	1.8	11.0	1.8	8.0	4.8	3	Fill
P-3S	4/88	14.45	16.33	11.5	3.0	11.5	3.0	8.5	6.0	3	Fill
P-4S	4/88	19.08	19.99	18.0	1.1	18.0	1.1	15.0	4.1	3	UD
P-5S	4/88	18.48	21.27	16.0	2.5	16.0	2.5	13.0	5.5	3	UD
P-6S	4/88	21.61	23.71	18.0	3.6	18.0	3.6	15.0	6.6	3	UD
P-6M	4/88	21.39	22.01	40.0	-18.6	40.0	-18.6	37.0	-15.6	3	UD
P-7S-A	4/88	10.98	12.55	9.0	2.0	9.0	2.0	6.0	5.0	3	UD
P-7S-B	4/88	10.98	11.99	14.0	-3.0	14.0	-3.0	11.0	-0.0	3	UD
P-8S	4/88	14.99	16.93	11.5	3.5	11.5	3.5	8.5	6.5	3	UD
P-9S	4/88	14.65	16.16	12.0	2.7	12.0	2.7	9.0	5.7	3	UD
P-10S	4/88	12.69	14.20	12.0	0.7	12.0	0.7	9.0	3.7	3	UD
P-11S	4/88	14.45	18.29	10.0	4.5	10.0	4.5	7.0	7.5	3	NE
P-12S-A	4/88	14.17	16.00	12.0	2.1	12.0	2.2	9.0	5.2	3	NE
P-12S-B	4/88	14.17	18.24	26.5	-12.3	15.0	-0.8	12.0	2.2	3	NE
P-13S	4/88	23.89	28.43	15.0	8.9	14.0	9.9	11.0	12.9	3	NE
P-14S	4/88	23.51	24.16	13.0	10.5	13.0	10.5	10.0	13.5	3	UD
P-14D	4/88	23.51	24.00	58.5	-35.0	50.0	-26.5	47.0	-23.5	3	Till
MW-1S	5/88	13.74	15.67	15.0	-1.3	13.0	0.7	3.0	10.7	10	Fill
MW-1D	5/88	13.74	16.34	50.0	-36.3	48.0	-34.3	38.0	-24.3	10	UD
MW-2S	5/88	12.68	14.50	20.0	-7.3	18.0	-5.3	8.0	4.7	10	Fill
MW-3S	5/88	14.52	16.67	20.0	-5.5	18.0	-3.5	8.0	6.5	10	UD/Fill
MW-4S	5/88	18.36	21.34	19.0	-0.6	16.0	2.4	6.0	12.4	10	UD/Fill
MW-5S	5/88	23.82	26.23	18.0	5.8	16.0	7.8	6.0	17.8	10	UD
MW-6S	5/88	11.62	14.04	30.0	-18.4	13.5	-1.9	3.5	8.1	10	UD
MW-7S	5/88	13.04	15.18	20.0	-7.0	18.0	-5.0	8.0	5.0	10	NE
MW-8S	5/88	15.00	17.53	30.0	-15.0	15.5	-0.5	5.5	9.5	10	UD/Fill
MW-9S	5/88	15.41	17.84	34.0	-18.6	13.0	2.4	3.0	12.4	10	UD/Fill

TABLE 2-2 (continued)

SUMMARY OF PIEZOMETER AND MONITORING WELL CONSTRUCTION DETAILS  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Well Number	Month/Year of Installation	<u>Elevation Data</u>		<u>Boring Data</u>		<u>Monitoring Well/Piezometer Data</u>						Strata Monitored
		Ground Surface	Top of Riser Pipe	Depth	Bottom Elevation	<u>Bottom of Monitoring Zone</u>		<u>Top of Monitoring Zone</u>		Length of Screen		
						Depth	Elevation	Depth	Elevation			
EP-1	--	21.82	22.98	--	--	--	--	--	--	--	--	
EP-2	--	22.95	24.59	--	--	--	--	--	--	--	--	
EP-5	--	12.60	15.94	--	--	--	--	--	--	--	--	
EP-6	--	10.00	11.06	--	--	--	--	--	--	--	--	
EP-7	--	13.81	14.51	--	--	--	--	--	--	--	--	
EP-8	--	18.59	20.02	--	--	--	--	--	--	--	--	

Notes:

1. Elevations and depths are reported in feet; elevations are referenced to Mean Sea Level.
2. UD = unconsolidated deposits.
3. -- = information not available.
4. NE = not evaluated.
5. Elevation data are based on surveys by Waterman Engineering Company of East Providence, RI and by Woodward-Clyde Consultants of Wayne, NJ.
6. Depths were measured in the field to the nearest 0.1 foot. Subsurface elevations for borings, monitoring wells, and piezometers are also reported the nearest 0.1 foot.

TABLE 2-3  
SUMMARY OF GROUND WATER ELEVATION  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Piezometer/ Well No.	Water Level Elevation 26 April 1988	Water Level Elevation 7 June 1988	Water Level Elevation 19 April 1989	Water Level Elevation 1 June 1989
P-1S	8.88	NM	10.16	9.57
P-1D	8.28	NM	9.48	8.68
P-2S	8.01	NM	9.34	8.54
P-3S	7.43	NM	8.28	6.66
P-4S	11.79	NM	12.81	12.11
P-5S	11.22	NM	12.06	11.51
P-6S	11.36	NM	12.34	11.74
P-6M	11.51	NM	12.47	11.93
P-7S-A	6.25	NM	7.44	6.75
P-7S-B	6.24	NM	7.39	6.76
P-8S	6.13	NM	7.12	6.65
P-9S	7.86	NM	9.34	8.40
P-10S	6.25	NM	7.20	6.69
P-11S	11.79	NM	12.33	12.16
P-12S-A	7.80	NM	9.12	8.23
P-12S-B	8.69	NM	10.19	10.20
P-13S	13.68	NM	14.73	NM
P-14S	14.91	NM	15.85	15.39
P-14D	15.10	NM	16.20	15.79
EP-1	10.48	NM	11.41	10.86
EP-2	13.79	NM	14.82	14.23
EP-5	7.49	NM	8.83	8.45
EP-6	6.11	NM	7.33	NM
EP-7	7.66	NM	9.91	9.16
EP-8	13.22	NM	14.27	13.60
MW-1S	NM	9.57	10.82	9.99
MW-1D	NM	9.97	9.74	9.13
MW-2S	NM	8.70	10.06	9.35
MW-3S	NM	8.27	9.10	8.53
MW-4S	NM	11.58	12.27	11.87
MW-5S	NM	14.85	15.80	15.39
MW-6S	NM	6.55	7.52	6.86
MW-7S	NM	6.97	8.03	7.33
MW-8S	NM	6.07	6.95	6.50
MW-9S	NM	11.33	12.52	11.86

Notes:

1. Elevations are reported in feet and referenced to Mean Sea Level.
2. NM = not measured
3. The Pawtuxet River elevation was recorded at the location of the railroad bridge on 19 April 1989 and 1 June 1989. The elevations are 6.96 and 6.46, respectively.

TABLE 3-1  
RAW MATERIALS AND INTERMEDIATES  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

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Methylene chloride, technical	TMHP Dry
bis(2-Chloroethyl) ether	Aminoethyl ethanolamine (AEEA)
Chlorobenzene	Soltrol 10
Methyl ethyl ketone (2-butanone)	Phenyl alpha-naphthylamine
Copper acetate	AMPS monomer (reaction grade)
Silver nitrate	Isopropylamine
Acrylonitrile, 35-45 ppm inhibitor	Chlorotoluene (Halso 99)
Chromium sulfate	Diocadecyl hydrogen phosphite
Toluene	Phenylhydrazine
Ethyl cellosolve (Ethylene glycol monoethyl ether)	Methyl styrenated phenol
Xylene	1,2-Diaminocyclohexane
Hydroquinone	Penicillin-V-sulfoxide benzhy
o-Nitroaniline (ONA)	Dimethylaminopropyl chloride
Ethylene glycol (1,2-ethanediol)	n-Octylamine
N-methyl-2-pyrrolidone	Allyloxyphenol
Hydrazine sulfate	Irgatan F liquid, new
Ethanol	Deriphat 160C
Hydrogen cyanamide 50%	Actinol FA-1
Ethyl acrylate, 25 ppm inhibitor	Vinyl butyl ether
Hexylene glycol	2,4-di-t-amylphenol
Ethylene chlorohydrin	Perfluoroalkylethyl iodide FCG600
p-Cresol	Perfluoroalkylethyl iodide FCG800
Methanol	Perfluoroalkylethyl iodide
Special naphtholite	Isopropanol
	Acetone

AM89-149TZ  
29 March 1990

TABLE 3-1 (continued)  
RAW MATERIALS AND INTERMEDIATES  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

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Nitrosyl sulfuric acid	Naphthalene
Phenol	Diisobutylene
Triethylene glycol	Glutethimide
Diethanolamine	p-Toluene sulfinic acid, sodium
Polyethylene glycol 400	Capric acid
Trichloroacetic acid	Pamoic acid, disodium salt
t-Butyl alcohol	Acetic acid
Methyl acetoacetate	Dimethylsebacate
Oxalic acid, crystal ACS	Azobenzene, technical
Butyl cellosolve (Ethylene glycol monobutyl ether)	Heptane
Malic acid	Oleic acid
	Amsco (mineral spirits)

TABLE 3-2  
FINAL PRODUCTS  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

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I. ADDITIVES GROUP

TINUVINS

Tinuvin P  
Tinuvin 144  
Tinuvin 326  
Tinuvin 327  
Tinuvin 328  
Tinuvin 440  
Tinuvin 770  
Tinuvin 900

IRGANOXES

Irganox 565  
Irganox 858  
Irganox 1010  
Irganox 1035  
Irganox 1076  
Irganox 1093  
Irganox 1300

IRGASTABS

Irgastab 2002

II. CHEMICALS GROUP

IRGASANS

Irgasan CF-3  
Irgasan DP300

MISCELLANEOUS CHEMICALS

Gycotan (Alkylphenoxysulfones)  
Dicrylate (Acrylamide/acrylate  
polymers)  
Nonisol (Polyethylene glycol  
aliphatic esters)  
Amine O (Alkyl imidazole)  
Tinofix, Gycofix  
(Dicyandiamide-formaldehyde  
condensation products)  
Irgapadol, Alrosol, Alrowet (Fatty acid  
esters/amides)  
Phenidone (Phenylpyrazolidones)

TINOPALS

Tinopal 4BM  
Tinopal RBS

TABLE 3-2 (continued)  
FINAL PRODUCTS  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

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III. AGRICULTURAL CHEMICALS  
GROUP

TRIAZINE HERBICIDES

Propazine

Simazine

IV. PHARMACETURICALS GROUP

Chlorthalidone (Hygroton)

Phenylbutazone (Butazolidin)

Imipramine (Tofranil)

Desipramine (Pertofrane)

Hydrochlorothiazide

Baclofen (Lioresal)

Carbamzaepine (Tegretol)



TABLE 5-1  
SOLID WASTE MANAGEMENT UNITS, AREAS OF CONCERN AND ADDITIONAL AREAS OF INVESTIGATION  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Number	Type	Study Area	Active Dates	Location	Description
<u>Solid Waste Management Units (SWMUs)</u>					
1	Hazardous waste storage area	Warwick Area	1981-1986	Northing: 248,975 Easting: 524,935	The hazardous waste storage area was designed for a maximum capacity storage of 768 55-gallon drums. Typically, this unit contained 300 to 400 drums. Various wastes were stored within this unit including: flammable liquids and solids, corrosive liquid and solids, organic mixtures and solids, non-hazardous organic mixtures and chloroform. The area was asphalt lined, diked and surrounded by a 6 ft high chain-link fence. The storage area was approximately 42 ft by 58 ft. The dike was capable of holding 48,000 gallons.
2	6000-gallon hazardous waste storage tank	Production Area	1981-1986	Northing: 249,130 Easting: 523,860	The 6000-gallon above ground tank was used to provide storage of process wastes containing acetone, toluene, monochlorobenzene, isopropanol, naptha, xylene, heptane, methanol and water. The carbon steel tank was 17 ft high, had a diameter of 8 ft, and was enclosed by an 8000-gallon capacity dike (14.5 ft x 19 ft x 4 ft high).
3	7500-gallon, 90-day accumulation tank	Production Area	1985-1986	Northing: 249,110 Easting: 523,890	The vertical above ground tank, which had a capacity of 7500 gallons, was used to store flammable liquids for periods of less than 90 days. The stainless steel tank was 17 ft high, had a diameter of 8.5 ft, and was enclosed by a 25,000-gallon dike (approximately 28 ft x 29 ft x 4 ft high).

TABLE 5-1 (Continued)  
SOLID WASTE MANAGEMENT UNITS, AREAS OF CONCERN AND ADDITIONAL AREAS OF INVESTIGATION  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Number	Type	Study Area	Active Dates	Location	Description
4	Trash compactor station	Production Area	1972-1986	Northing: 249,050 Easting: 524,010	The trash compactor station had two compactors of 30 and 55 cubic yard capacity, and only handled packaging material paper wastes and washed fiber drums. The trash compactor area (21 ft x 36 ft) was concrete lined and drained to the waste water treatment plant.
5	River sediment storage area	Warwick Area	1971-1976	Northing: 249,020 Easting: 525,220	Approximately 6630 cubic yards of sediment dredged from the Pawtuxet River was piled in this area. The sediment was dredged as part of the removal of the original cofferdam/waste water outfall. The sediment was removed from the site in 1976. The natural grade of this area was restored in 1977.
6	Zinc oxide/soil pile	Warwick Area	Late 1960's to present	Northing: 248,920 Easting: 524,615	Approximately 25 cubic yards of soil containing about 10 percent zinc oxide residue exists on site. The zinc oxide residue was from an incident involving a broken railcar. The soil pile is approximately 50 ft long by 7 ft wide by 2 ft high.
7	Chlorosulfonic acid spill area	Production Area	1961	Northing: 249,080 Easting: 523,955	Approximately 500 gallons of chlorosulfonic acid were spilled over an area about 10 ft x 20 ft.
8	Prussian Blue spill area	Production Area	1956	Northing: 248,975 Easting: 523,990	Blue-stained soil, believed to be from Prussian Blue, resulted from a spill of unknown quantity. About 300 cubic yards of that soil were excavated and subsequently removed.

TABLE 5-1 (Continued)  
SOLID WASTE MANAGEMENT UNITS, AREAS OF CONCERN AND ADDITIONAL AREAS OF INVESTIGATION  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Number	Type	Study Area	Active Dates	Location	Description
9	Waste water pipeline break	Warwick Area	12 Jan 1982	Northing: 249,010 Easting: 524,840	A break in the main raw waste transfer line resulted in the discharge of about 24,000 gallons of waste water. The waste water entered the surface water runoff catchment system and discharged to the Pawtuxet River. The waste water typically contained halogenated and non-halogenated solvents and other organic compounds routinely used in the chemical manufacturing process.
10	Waste water pipeline break	Waste Water Treatment Area	7 Sept 1983	Northing: 249,575 Easting: 524,955	A break in an underground waste water line resulted in a discharge of about 50,000 gallons. The discharge flowed into a small on-site pond and then diverted to the Pawtuxet River. The pH of the released waste water was 8.5; the chemical oxygen demand (COD) was 1010 ppm. This discharge contained acetone (31 pounds), isopropyl alcohol (45 pounds), toluene (7 pounds), xylene (1.7 pounds), zinc (0.25 pounds), and nitrobenzene (0.125 pounds).
11	Toluene spill area	Production Area	1983	Northing: 248,990 Easting: 523,770	The estimated loss of toluene associated with this SWMU is between 9 and 90 pounds. The loss occurred via a subsurface sump associated with Building 11.
12	Waste water treatment plant	Waste Water Treatment Area	1970-1983	Northing: 249,405 Easting: 525,015	This area formerly was occupied by the waste water treatment plant. Biological trickling towers were used and periodic sump overflows from these towers resulted in discharges to the river. Influent to the trickling towers routinely contained volatile and semi-volatile organic compounds. Additional releases from SWMU-12 in excess of the NPDES permit requirements have been reported for zinc, BOD, and phenols. For two releases, chloroform was discharged to the river.

TABLE 5-1 (Continued)  
SOLID WASTE MANAGEMENT UNITS, AREAS OF CONCERN AND ADDITIONAL AREAS OF INVESTIGATION  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Number	Type	Study Area	Active Dates	Location	Description
<u>Areas of Concern AOCs:</u>					
13	Process building area	Production Area	1930-1986		Area in which most of the production activities occurred.
14	Atlantic Tubing and Rubber Company property	Adjacent to and west of the Production Area	1981-present		This property was never used or developed by CIBA-GEIGY.
<u>Additional Areas of Investigation (AAOIs):</u>					
15	Laboratory building waste water sump	Production Area	1961-1987		The sump functioned as part of normal operations within the laboratory building. The gravity sump drained to sewer lines that discharged to the POTW.
16	Maintenance department cleaning area	Warwick Area	mid 1960s-1986		Area in which steam cleaning of maintenance equipment occurred. Rinse water drained to nearby surface water catch basin.

NOTE: CIBA-GEIGY has identified the two Additional Areas of Investigation; no releases are known, but the potential for a past release existed.

TABLE 6-1

FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN GROUND WATER SAMPLES  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	Production		Waste Water		Production		Production		Warwick		Production				Production	
	GW-1	GW-4	GW-6	GW-14	GW-5	GW-6	GW-4	GW-9	GW-8	GW-12	GW-2	GW-2A	GW-8	GW-8D	GW-3	GW-7
	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(EPA)	(CG)	(CG)	(EPA)	(CG)
	(1)															
Metals (ppb)																
arsenic	<2.8	ND	4.0	10	395	<19	<2.8	ND	<2.8	ND	609	365	19	<38	6.1	ND
cadmium	<4.7	5.8	<4.7	ND	<4.7	<4.2	<4.7	9.6	<4.7	<9.3	<4.7	<4.7	5.1	10	<4.7	<3.9
chromium	<9.4	<13	<9.4	<8.9	21	<51	15	<29	<9.4	<15	13	<9.4	<28	<98	<9.4	<4.4
lead	1.7	27	2.3	9.8	93	186	178	24	5.18	13	17	<1.7	57	247	<1.7	5.9
manganese	1060	NA	5470	NA	838	NA	64	NA	18	NA	593	577	NA	NA	<6.5	NA
zinc	13800	17700	1000	<1510	12600	18800	2510	4040	5360	<7630	13600	195	25520	<43000	<20	<1050
Volatile Organics (ppb)																
BTEX COMPOUNDS:																
toluene	2J	ND	ND	ND	27J	ND	ND	ND	ND	ND	22J	ND	23	31	ND	1J
total xylenes	94	62	ND	ND	46J	11	ND	21	ND	ND	780	460	2923D	2377D	1300	2887D
ethylbenzene	27	15	ND	ND	ND	ND	ND	5	ND	ND	540	ND	778D	610D	ND	333D
benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4J	24J	32
	123	77	ND	ND	73J	11	ND	26	ND	ND	1342J	460	3724D	3022D	1324J	3253JD
CHLORINATED VOLATILES:																
methylene chloride	ND	6J	1J	6J	ND	4J	ND	ND	2J	ND	7J	8J	ND	ND	11J	ND
tetrachloroethylene	2J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3J	4J	ND	120
chlorobenzene	ND	ND	ND	ND	1100	ND	ND	2J	ND	ND	14J	ND	38	31	1800	1735D
1,2-dichloroethylene	ND	ND	ND	ND	210	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE 6-1 (continued)

## FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN GROUND WATER SAMPLES

CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	Production		Waste Water		Production		Production		Warwick		Production				Production	
	GW-1	GW-4	GW-6	GW-14	GW-5	GW-6	GW-4	GW-9	GW-8	GW-12	GW-2	GW-2A	GW-8	GW-8D	GW-3	GW-7
	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(EPA)	(CG)	(CG)	(EPA)	(CG)
vinyl chloride	ND	ND	ND	ND	66J	12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6
trans-1,2-dichloroethene	ND	ND	ND	ND	ND	130	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2J	6J	1J	6J	1376	146J	ND	2J	2J	ND	21J	8J	41J	34	1811	1861
OTHER COMPOUNDS:																
acetone	ND	7JB	ND	57B	ND	5JB	ND	12B	2J	ND	190	240	ND	75B	ND	ND
<u>Semi-Volatile Organics (ppb)</u>																
ACID EXTRACTABLES:																
2,4-dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	21	ND
2-chlorophenol	ND	ND	ND	ND	29	ND	ND	ND	ND	ND	ND	ND	ND	ND	13	ND
phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2000	2400	230	ND	25	ND
	ND	ND	ND	ND	29	ND	ND	ND	ND	ND	2000	2400	230	ND	59	ND
CHLORINATED BENZENES:																
1,2-dichlorobenzene	10	ND	ND	ND	230	120	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-dichlorobenzene	ND	ND	ND	ND	24	26	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	10	ND	ND	ND	254	146	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE 6-1 (continued)

FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN GROUND WATER SAMPLES  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	Production		Waste Water		Production		Production		Warwick		Production				Production	
	GW-1	GW-4	GW-6	GW-14	GW-5	GW-6	GW-4	GW-9	GW-8	GW-12	GW-2	GW-2A	GW-8	GW-8D	GW-3	GW-7
	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(EPA)	(CG)	(CG)	(EPA)	(CG)
POLYNUCLEAR AROMATIC HYDROCARBONS:																
fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	2J	ND	ND	ND	ND	ND	ND
pyrene	ND	ND	ND	2J	ND	ND	ND	ND	ND	2J	ND	ND	ND	2J	ND	ND
naphthalene	ND	ND	ND	ND	ND	4J	ND	ND	ND	ND	ND	ND	6J	4J	ND	ND
benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	8J	ND	ND	ND	2J	ND	ND
	ND	ND	ND	2J	ND	4J	ND	ND	ND	12J	ND	ND	6J	8J	ND	ND
PHTHALATE ESTERS:																
butyl benzylphthalate	ND	ND	ND	2J	ND	ND	ND	ND	ND	2J	ND	ND	ND	ND	ND	ND
bis(2-ethyl hexyl) phthalate	ND	368	ND	508	15	528	24	368	ND	268	ND	ND	310	568	ND	248
di-n-octyl phthalate	ND	ND	ND	10J	ND	ND	ND	ND	ND	2J	ND	ND	ND	ND	ND	ND
diethyl phthalate	ND	ND	ND	ND	ND	ND	ND	2J	ND	2J	ND	ND	ND	ND	ND	ND
di-n-butyl phthalate	ND	ND	ND	ND	ND	ND	ND	2J	ND	2J	ND	ND	ND	2J	ND	ND
	ND	368	ND	628J	15	528	24	408J	ND	348J	ND	ND	310	588J	ND	248
OTHER COMPOUNDS:																
4-chloroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	130	ND
dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-dichlorobenzidine	ND	ND	ND	ND	ND	ND	ND	ND	ND	36	ND	ND	ND	ND	ND	ND
chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	10J	ND	ND	ND	ND	ND	ND
benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	18J	ND	ND	ND	ND	ND	ND
benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	10J	ND	ND	ND	ND	ND	ND
dibenzo(a,b)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	4J	ND	ND	ND	ND	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	78J	ND	ND	ND	ND	130	ND

TABLE 6-1 (continued)

FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN GROUND WATER SAMPLES  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	Production		Waste Water		Production		Production		Warwick		Production				Production	
	GW-1	GW-4	GW-6	GW-14	GW-5	GW-6	GW-4	GW-9	GW-8	GW-12	GW-2	GW-2A	GW-8	GW-8D	GW-3	GW-7
	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(CG)	(EPA)	(EPA)	(CG)	(CG)	(EPA)	(CG)
<u>PCBs (ppb)</u>	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	ND	NA	NA	ND	NA
<u>Pesticides (ppb)</u>	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	ND	NA	NA	ND	NA

**NOTES:**

ppb = parts per billion

NA = not analyzed.

ND = not detected.

&lt; = Less than the number shown; indicates the detection limit.

(CG) = CIBA-GEIGY sample.

(EPA) = United States Environmental Protection Agency sample collected by Versar Inc.

B = Analyte was found in the blank.

Table based on data reported by Versar (1988) and CIBA-GEIGY file data.

J = Presence of compound detected, value estimated (Versar, 1988).

J = Estimated value based on QA/QC review or the compound is present below the specified detection limit (CIBA-GEIGY)

Split samples were obtained during ground water sampling. The samples and splits are as follows: GW-1 (EPA) and GW-4 (CG), GW-6 (EPA) and GW-14 (CG), GW-5 (EPA) and GW-6 (CG), GW-4 (EPA) and

GW-9 (CG), GW-8 (EPA) and GW-12 (CG), GW-2 (EPA) and GW-8 (CG), GW-2A (EPA) and GW-8D (CG), GW-3 (EPA) and GW-7 (CG).

Sample GW-2A (EPA) is a field duplicate of sample GW-2 (EPA). Sample GW-8D (CG) is a field duplicate of sample GW-8 (CG).

Samples were collected on 11 June 1987.

D = Calculated from 10X dilution.



TABLE 6-2

FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN SOIL SAMPLES  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	SS-1 (EPA)	SS-1A (EPA)	SS-4 (CG)	SS-4D (CG)	SS-2 (EPA)	SS-2 (CG)	SS-3 (EPA)	SS-1 (CG)	BG1 (EPA)	SS-3 (CG)
<u>Metals (ppm)</u>	NA	NA	NA	NA	NA	NA				
antimony	--	--	--	--	--	--	137	ND	19	ND
arsenic	--	--	--	--	--	--	31	ND	3.5	ND
barium	--	--	--	--	--	--	622	NA	40	NA
beryllium	--	--	--	--	--	--	<2.2	0.6	<0.49	0.3J
cadmium	--	--	--	--	--	--	14	ND	1.2	ND
chromium	--	--	--	--	--	--	407	97	14	15
copper	--	--	--	--	--	--	NA	126	NA	35
iron	--	--	--	--	--	--	64500	NA	10400	ND
lead	--	--	--	--	--	--	5.2	34J	<0.4	45J
magnesium	--	--	--	--	--	--	5760	NA	1490	NA
manganese	--	--	--	--	--	--	971	NA	173	NA
mercury	--	--	--	--	--	--	38	0.83	2.7	ND
nickel	--	--	--	--	--	--	<30	ND	8.3	ND
selenium	--	--	--	--	--	--	1.5	ND	0.25	ND
silver	--	--	--	--	--	--	<8.0	ND	<1.8	ND
vanadium	--	--	--	--	--	--	101	NA	32	NA
zinc	--	--	--	--	--	--	11000	2830J	200	217J
<u>Volatile Organics (ppm)</u>										
toluene	ND	ND	ND	ND	ND	0.008	ND	0.007	ND	0.009
methylene chloride	0.1B	0.051B	0.005JB	0.003JB	0.05	0.008B	ND	0.003JB	ND	0.007B
acetone	0.003J	0.005J	0.045JB	ND	0.01J	0.12J	ND	0.085J	ND	0.130J
	0.103JB	0.056JB	0.050JB	0.003JB	0.06J	0.136JB	ND	0.095JB	ND	0.146JB

TABLE 6-2 (continued)

FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN SOIL SAMPLES  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	SS-1 (EPA)	SS-1A (EPA)	SS-4 (CG)	SS-4D (CG)	SS-2 (EPA)	SS-2 (CG)	SS-3 (EPA)	SS-1 (CG)	BG1 (EPA)	SS-3 (CG)
<u>Semi-Volatile Organics (ppm)</u>					ND		ND			
POLYNUCLEAR AROMATIC HYDROCARBONS:										
fluoranthene	1.5	0.31J	0.53	0.6	--	ND	--	1.5	6.1	4.0
pyrene	1.3	0.29J	0.3JB	0.41B	--	0.039JB	--	0.68JB	ND	2.4J
chrysene	0.68J	0.2J	0.27J	0.3J	--	ND	--	0.64	3.7	1.8
benzo(b)fluoranthene	0.75	0.23J	ND	ND	--	ND	--	1.9	3.4J	4.7
benzo(a)pyrene	0.51J	0.14J	0.34J	0.41	--	ND	--	0.8	2.1J	1.9
benzo(g,h,i)perylene	0.3J	ND	ND	ND	--	ND	--	0.64	ND	1.0
benzo(a)anthracene	ND	0.37	0.19J	0.26J	--	ND	--	ND	ND	1.6
phenanthrene	1.1	0.17J	0.19J	0.26J	--	ND	--	0.42	4.2	1.8
anthracene	0.3J	ND	0.076J	0.11J	--	ND	--	0.15J	1.2J	0.47
acenaphthylene	ND	ND	0.038J	ND	--	ND	--	0.23J	ND	0.43
naphthalene	ND	ND	ND	ND	--	ND	--	0.15J	ND	0.072J
acenaphthene	ND	ND	ND	ND	--	ND	--	ND	ND	0.11J
benzo(k)fluoranthene	ND	ND	0.53J	0.67	--	ND	--	ND	ND	ND
indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	--	ND	--	0.8	ND	1.2
	6.44J	1.71J	2.464JB	3.02JB		0.039JB		7.91JB	20.7	21.482
PHTHALATE ESTERS:										
dimethylphthalate	1.4	ND	ND	ND	--	ND	--	ND	ND	ND
di-n-octylphthalate	ND	ND	ND	ND	--	ND	--	0.45	ND	ND
butylbenzylphthalate	ND	ND	ND	ND	--	ND	--	0.15J	22.0	5.8J
di-n-butylphthalate	ND	ND	0.15J	0.45	--	0.039J	--	ND	ND	ND
bis(2-ethyl hexyl) phthalate	ND 1.4	0.14J 0.14J	0.49B 0.64JB	ND 0.45	--	ND 0.039J	--	1.7B 2.30JB	ND 22.0	1.8B 7.6JB

TABLE 6-2 (continued)

FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN SOIL SAMPLES  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	SS-1 (EPA)	SS-1A (EPA)	SS-4 (CG)	SS-4D (CG)	SS-2 (EPA)	SS-2 (CG)	SS-3 (EPA)	SS-1 (CG)	BG1 (EPA)	SS-3 (CG)
OTHER COMPOUNDS:										
1,2 dichlorobenzene	ND	ND	ND	ND	--	0.039J	--	ND	ND	ND
hexachlorocyclopentadiene	ND	ND	ND	ND	--	ND	--	ND	ND	0.036J
2-nitroaniline	ND	ND	ND	ND	--	ND	--	0.45	ND	ND
dibenzofuran	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>--</u>	<u>ND</u>	<u>--</u>	<u>ND</u>	<u>ND</u>	<u>0.072J</u>
	ND	ND	ND	ND	--	0.039J	--	0.45	ND	0.108J
<u>PCBs (ppm)</u>										
			ND	ND		ND			ND	ND
aro-chlor-1254	0.031	0.005	--	--	0.009	--	3.2	ND	--	--
aro-chlor-1260	<u>ND</u>	<u>---</u>	<u>--</u>	<u>--</u>	<u>ND</u>	<u>--</u>	<u>ND</u>	<u>59</u>	<u>--</u>	<u>--</u>
	0.031	0.005	--	--	0.009	--	3.2	59	--	--
<u>Pesticides (ppm)</u>										
	ND	ND	ND	ND	ND	ND	ND		ND	
heptachlorepoide	--	--	--	--	--	--	--	1.3	--	ND
delta-BHC	<u>--</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>ND</u>	<u>--</u>	<u>0.12</u>
	--	--	--	--	--	--	--	1.3	--	0.12

TABLE 6-2 (continued)

FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN SOIL SAMPLES  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

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NOTES:

ppm = parts per million.

ND = not detected.

< = Less than the number shown; Indicates the detection limit.

(CG) = CIBA-GEIGY sample.

(EPA) = United States Environmental Protection Agency sample collected by Versar Inc.

B = Analyte was found in the blank.

Table based on data reported by Versar (1988) and CIBA-GEIGY file data.

J = Presence of compound detected, value estimated (Versar, 1988).

J = Estimated value based on QA/QC review or the compound is present below the specified detection limit (CIBA-GEIGY)

Split samples were obtained during soil sampling. The samples and splits are as follows: SS-1 (EPA) and SS-4 (CG), SS-1A (EPA) and SS-4D (CG), SS-2 (EPA) and SS-2 (CG), SS-3 (EPA) and SS-1 (CG). Samples BG1 (EPA) and SS-3 (CG) were obtained from background locations.

Sample SS-1A (EPA) is a field duplicate of sample SS-1 (EPA). Sample SS-4D (CG) is a field duplicate of sample SS-4 (CG).

Samples were collected on 11 June 1987.

NA = not analyzed.

TABLE 6-3

**PRELIMINARY INVESTIGATION SAMPLING AND ANALYSIS PROGRAM SUMMARY  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND**

<u>Sample Location</u>	<u>Area</u>	<u>Media</u>	<u>Analytical Parameters</u>
MW-1S	Production Area	Soil (subsurface)	Sample not analyzed*
MW-1D	Production Area	Soil (subsurface)	Appendix IX
MW-2S	Production Area	Soil (subsurface)	TCL + 30
MW-3S	Production Area	Soil (subsurface)	TCL + 30
MW-4S	Production Area	Soil (subsurface)	TCL + 30
MW-5S	Production Area	Soil (subsurface)	TCL + 30
MW-6S	Warwick Area	Soil (subsurface)	Appendix IX
MW-7S	Waste Water Treatment Area	Soil (subsurface)	Appendix IX
MW-8S	Waste Water Treatment Area	Soil (subsurface)	TCL + 30
MW-9S	Waste Water Treatment Area	Soil (subsurface)	TCL + 30
RS-1	Warwick Area	Soil (surficial)	TCL + 30
RS-2	Warwick Area	Soil (surficial)	TCL + 30
RS-3	Warwick Area	Soil (surficial)	TCL + 30
RS-4	Warwick Area	Soil (surficial)	TCL + 30
RS-5	Warwick Area	Soil (surficial)	Appendix IX
MW-1S	Production Area	Ground Water	TCL + 30
MW-1D	Production Area	Ground Water	Appendix IX
MW-2S	Production Area	Ground Water	TCL + 30
MW-3S	Production Area	Ground Water	TCL + 30
MW-4S	Production Area	Ground Water	TCL + 30
MW-5S	Production Area	Ground Water	TCL + 30
MW-6S	Warwick Area	Ground Water	Appendix IX
MW-7S	Waste Water Treatment Area	Ground Water	Appendix IX
MW-8S	Waste Water Treatment Area	Ground Water	TCL + 30
MW-9S	Waste Water Treatment Area	Ground Water	TCL + 30

Notes:

TCL + 30 = Targeted Compound List parameters plus a 30-compound library search

\* = Adjacent boring MW-1D provided the sample required to investigate soil quality at that location.

TABLE 6-4  
PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN FIELD BLANK SAMPLES  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

		(1,2,4) Field Blank	(1,2,4) Field Blank
Sampling Location:		Soil	Water
Representative Matrix:		5/18/88	6/8/88
Sampling Date:		447-006	488-005
Laboratory I.D. Number:			
<hr/>			
		Chemical (3)	
		Compound Group	
<hr/>			
<u>Volatile Organic Compounds</u>			
<hr/>			
BTEX:			
toluene	alkyl aromatic	ND	4 J
<hr/>			
CHLORINATED VOLATILE COMPOUNDS:			
1,2-dichloropropane	aliphatic halide	4 J	ND
methylene chloride	aliphatic halide	--	10 B
tetrachloroethylene	aliphatic halide	ND	ND
<hr/>			
OTHER COMPOUNDS:			
acetone			4 JB
2-butanone	ketone	ND	16
<hr/>			
VOC - TOTAL		4	34
<hr/>			
<u>Semi-Volatile Organics</u>			
<hr/>			
aldrin	pesticide	0.01 J	ND
alpha-BHC	pesticide	0.01 J	ND
Delta-BHC	pesticide	0.01 J	ND
gamma-BHC	pesticide	0.01 J	ND
4,4'-DDE	pesticide	0.01 J	ND
4,4'-DDT	pesticide	0.01 J	ND
dieldrin	pesticide	0.01 J	ND
<hr/>			
PHthalate ESTERS:			
bis(2-ethylhexyl)phthalate	DAE	--	2 JB
diethyl phthalate	DAE	0.7 J	ND
di-n-octyl phthalate	DAE	3J	ND
<hr/>			
PESTICIDES			
endosulfan II	pesticide	0.01 J	ND
endrin	pesticide	0.01 J	ND
heptachlor	pesticide	0.01 J	ND
heptachlor epoxide	pesticide	0.01 J	ND
kepone	pesticide	0.06 J	ND
<hr/>			
SVO - TOTAL		3.87	2 ND
<hr/>			

TABLE 6-4 (continued)  
PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN FIELD BLANK SAMPLES  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

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NOTES:

- (1) COMPOUND CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ppb).
- (2) ND = NOT DETECTED OR BELOW METHOD DETECTION LIMIT.  
J = CONCENTRATION IS AN ESTIMATED VALUE LESS THAN THE METHOD DETECTION LIMIT.  
B = CONTAMINANT PRESENT IN LABORATORY METHOD BLANK.
- (3) DAE = DICARBOXYLIC ACID ESTER.
- (4) APPENDIX IX ANALYSIS.

TABLE 6-5

PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN TRIP BLANK SAMPLES  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

	(1,2)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2)
Sampling Location:	Trip Blank	TB-2	TB-3	TB-4	TB-1	TB-2	TB-3
Representative Matrix:	Soil	Soil	Soil	Soil	Water	Water	Water
Sampling Date:	5/17/88	5/18/88	5/19/88	5/23/88	6/7/88	6/8/88	6/9/88
Laboratory I.D. Number	442-004	447-009	450-003	454-001	482-005	454-008	492-002

<u>Volatile Organic Compounds</u>	<u>Chemical Compound Group</u>						
BTEX COMPOUNDS:							
benzene	aromatic	--	ND	4 JB	--	--	--
methylene chloride	aliphatic halide	--	ND	29 B	--	--	--
toluene	alkyl aromatic	--	ND	1 JB	--	--	--
OTHER COMPOUNDS:							
acetone	ketone	ND	ND	ND	56	ND	--
-----							
unknown		ND	ND	5 T	ND	ND	--
VOC - SUBTOTAL		0	0	34	56	0	0
TIC - SUBTOTAL		0	0	5	0	0	0
VOC + TIC - TOTAL		0	0	39	56	0	0

**NOTES:**

(1) COMPOUND CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ppb).

(2) -- = NO DATA OR NOT ANALYZED.

ND = NOT DETECTED OR BELOW METHOD DETECTION LIMIT.

J = CONCENTRATION IS AN ESTIAMTED VALUE LESS THAN THE METHOD DETECTION LIMIT.

B = CONTAMINANT PRESENT IN LABORATORY METHOD BLANK.

T = TENTATIVELY IDENTIFIED COMPOUND (TIC).



TABLE 6-6  
CIBA-GEIGY PRELIMINARY INVESTIGATION SUMMARY OF INORGANIC CONSTITUENTS DETECTED IN SOIL SAMPLES  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	(1,2)	(1)	(1)	(1)	(1)	(1,3)	(1,2)	(1,2)	(1)	(1)	(1)	(1)	(1)	(1)	(1,2)	(2,4)
Sample Number:	MW-1D	MW-2S	MW-3S	MW-4S	MW-5S	DUP-1	MW-6S	MW-7S	MW-8S	MW-9S	RS-1	RS-2	RS-3	RS-4	RS-5	FB
Lab I.D. Number:	447-008	442-001	442-002	442-003	454-004	454-003	447-007	450-001	447-001	454-002	447-002	447-003	447-004	447-005	450-002	447-006
Depth:	4-6 ft	3.5-7.5 ft	4-10 ft	5-9 ft	4-8 ft	4-8 ft	3-5 ft	5-7 ft	5-7 ft	2-6 ft	1 ft	1 ft	1 ft	1 ft	1 ft	--
Date:	5/17/88	5/17/88	5/17/88	5/17/88	5/23/88	5/23/88	5/18/88	5/19/88	5/19/88	5/23/88	5/18/88	5/18/88	5/18/88	5/18/88	5/19/88	5/18/88
Analyte																
aluminum	7650	5210	6310	5840	5840	6780	10900	6390	2970	6790	6630	6030	6480	5880	2960	64.3
antimony	<15.0	<16.9	<19.4	<17.2	<13.0	<12.6	<20.8	<15.2	<12.6	<12.9	<12.9	<13.8	<13.4	<14.4	44.3	<60.0
arsenic	4.70	3.6	8.2	4.10	2.90	2.90	4.80	7.70	<0.64	<0.66	4.70	5.40	4.90	3.90	1.30	26.0
barium	63.9	606	99.5	40.8	28.3	38.4	74.1	127	25.6	49.9	74.4	142	65.5	81.0	30.2	65.9
beryllium	<0.15	<0.17	<0.19	<0.17	<0.13	<0.13	1.00	<0.15	<0.13	<0.13	<0.13	<0.14	<0.13	<0.14	<0.15	<0.60
cadmium	<1.20	<1.40	2.6	<1.40	<1.10	<1.10	<1.70	<1.30	<1.10	<1.1	<1.10	<1.20	<1.10	<1.20	11.0	<5.00
calcium	2270	3380	6480	1370	617	610	1780	5230	897	1750	2130	1960	1550	2240	598	256
chromium	17.1	14.6	456	10.4	7.97	9.48	15.4	135	4.40	9.91	24.4	24.4	10.6	38.6	20.2	5.10
cobalt	3.49	3.41	9.22	4.81	4.45	5.14	4.05	4.12	1.64	5.40	4.70	4.36	4.19	3.93	3.41	<5.00
copper	186	25.2	221	12.1	7.17	8.32	18.6	115	42.2	10.7	48.2	574	31.4	34.5	26.1	19.1
iron	13300	11200	76600	12200	11100	11700	17900	9520	3910	14400	14300	12500	13000	12100	14200	176
lead	49.3	67.2	197	5.30	16	14.7	29.3	265	7.97	11.9	43.7	383	80.0	84.1	6.60	<21.0
magnesium	1410	1970	1480	1960	1670	1600	1520	1440	944	1560	1520	1910	1530	1480	1020	<200
manganese	175	118	3850	140	216	243	169	185	41.3	164	357	196	225	255	146	<6.10
mercury	<0.08	0.18	<0.10	<0.10	<0.05	<0.06	<0.12	0.30	<0.06	<0.05	0.34	0.21	0.07	0.22	0.17	<0.20
nickel	11.4	11	12.4	10.1	8.17	6.25	7.54	10.6	2.71	7.07	8.80	29.8	8.17	10.2	11.0	<11.0
potassium	538	913	564	446	534	526	365	569	426	1090	461	436	476	632	414	<290.0
selenium	1.03	<0.33	<0.39	<0.37	<0.26	<0.26	0.81	0.40	<0.29	<0.26	0.38	0.86	0.35	0.48	<0.30	<2.40
silver	<0.50	0.68	2.46	0.57	0.72	0.42	<0.69	1.95	<0.42	<0.04	<0.43	1.60	<0.44	<0.48	<0.50	<2.00
sodium	359	356	418	337	252	251	387	338	161	411	211	249	206	274	254	1260
thallium	<0.67	<0.66	<0.78	<0.75	<0.52	<0.52	<0.92	<0.60	<0.57	<0.53	<0.57	<0.62	<0.60	<0.64	<0.67	<4.80

TABLE 6-6 (continued)

CIBA-GEIGY PRELIMINARY INVESTIGATION SUMMARY OF INORGANIC CONSTITUENTS DETECTED IN SOIL SAMPLES  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	(1,2)	(1)	(1)	(1)	(1)	(1,3)	(1,2)	(1,2)	(1)	(1)	(1)	(1)	(1)	(1,2)	(2,4)	
Sample Number	MW-1D	MW-2S	MW-3S	MW-4S	MW-5S	DUP-1	MW-6S	MW-7S	MW-8S	MW-9S	RS-1	RS-2	RS-3	RS-4	RS-5	FB
Lab I.D. Number	447-008	442-001	442-002	442-003	454-004	454-003	447-007	450-001	447-001	454-002	447-002	447-003	447-004	447-005	450-002	447-006
Depth	4-6 ft	3.5-7.5 ft	4-10 ft	5-9 ft	4-8 ft	4-8 ft	3-5 ft	5-7 ft	5-7 ft	2-6 ft	1 ft	1 ft	1 ft	1 ft	1 ft	--
Date	5/17/88	5/17/88	5/17/88	5/17/88	5/23/88	5/23/88	5/18/88	5/19/88	5/19/88	5/23/88	5/18/88	5/18/88	5/18/88	5/18/88	5/19/88	5/18/88
vanadium	27.4	26.6	25.4	16.8	11.5	12.2	15.9	13.0	4.46	13.0	13.8	18.6	15.1	18.5	15.0	<4.00
zinc	48.9	138	444	34.4	42.5	55.0	159	320	38.7	111	94.2	2320	112	217	24600	63.1
tin	<125	NA	NA	NA	NA	NA	<173	<126	NA	NA	NA	NA	NA	NA	<126	<500
cyanide	<0.63	23.9	5.07	<0.73	<0.56	<0.54	<0.87	0.69	<0.54	<0.55	0.55	0.62	<0.56	1.38	1.37	<10.0
fluoride	122.7	NA	NA	NA	NA	NA	165.7	159	NA	NA	NA	NA	NA	NA	121	1300
sulfide	456.0	NA	NA	NA	NA	NA	<1.0	<1.0	NA	NA	NA	NA	NA	NA	<1.0	<5.0

**NOTES:**

(1) CONCENTRATIONS IN mg/kg (ppm).

(2) MOST SOIL SAMPLES ANALYZED FOR TCL METALS; SELECTED SAMPLES (MW-1D, MW-6, MW-7, RS-5 and FB) WERE ANALYZED FOR APPENDIX IX METALS.

(3) DUPLICATE SAMPLE (DUP-1) COLLECTED AT MW-5.

(4) FIELD BLANK (FB) PERFORMED ON SPLIT-SPOON SAMPLER FOR MW-6 (VALUES REPORTED IN ug/l).

(5) &lt; = LESS THAN THE NUMBER SHOWN; INDICATES THE DETECTION LIMIT.

NA = NOT ANALYZED.

TABLE 6-7

PRELIMINARY INVESTIGATION SUMMARY OF INORGANIC CONSTITUENTS DETECTED IN GROUND WATER SAMPLES  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	(1)	(1,2)	(1)	(1)	(1)	(1)	(1,2)	(1,2)	(1)	(1)	(1,3)	(1,2,4)
Sample Number:	MW-1S	MW-1D	MW-2S	MW-3S	MW-4S	MW-5S	MW-6S	MW-7S	MW-8S	MW-9S	DUP	FB-1
Lab I.D. Number:	482-002	488-007	482-004	482-001	482-003	492-001	488-004	488-006	488-002	488-001	488-003	488-005
Date:	6/7/88	6/8/88	6/7/88	6/7/88	6/7/88	6/9/88	6/8/88	6/8/88	6/8/88	6/8/88	6/8/88	6/8/88
<hr/>												
<b>Analyte</b>												
chromium	17.9	11.7	34.5	8.20	46.7	13.8	8.00	11.9	62.4	11.6	7.90	<3.00
iron	4260	27900	6360	14800	71500	10100	15000	20100	35800	3680	2260	<84.0
lead	9.80	5.60	192	16.2	59.1	16.5	6.50	4.50	24.6	2.60	1.8	<0.70
manganese	622	5050	445	1270	4620	1810	963	1160	4100	2170	2110	<6.10
cyanide	<10.0	<10.0	<10.0	<10.0	<10.0	15.5	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
fluoride	NA	760	NA	NA	NA	NA	480	540	NA	NA	NA	<450
sulfide	NA	<1000	NA	NA	NA	NA	<1000	<1000	NA	NA	NA	<1000

**NOTES:**

- (1) CONCENTRATIONS IN MICROGRAMS PER LITER (ppb).
- (2) MOST GROUND WATER SAMPLES WERE ANALYZED FOR TCL METALS; SELECTED SAMPLES (MW-1D, MW-6, MW-7 and FB-1) WERE ANALYZED FOR APPENDIX IX METALS.
- (3) DUPLICATE SAMPLE (DUP) COLLECTED AT MW-9.
- (4) FIELD BLANK (FB-1) PERFORMED ON BAILER FOR MW-6.
- (5) < = LESS THAN THE NUMBER SHOWN; INDICATES THE DETECTION LIMIT.
- NA = NOT ANALYZED.

TABLE 6-8

PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES FROM THE PRODUCTION AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

		(1,2,4)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2,5)
Sampling Location:		MW-1D	MW-2S	MW-3S	MW-4S	MW-5S	DUP-1
Sampling Depth:		4-6 ft	3.5-7.5 ft	4-10 ft	5-9 ft	4-8 ft	4-8 ft
Sampling Date:		5/18/88	5/17/88	5/17/88	5/17/88	5/23/88	5/23/88
Laboratory I.D. Number:		447-008	442-001	442-002	442-003	454-004	454-003

<u>Volatile Organic Compounds</u>	<u>Chemical<sup>(3)</sup> Compound Group</u>						
BTEX COMPOUNDS:							
ethyl benzene	alkyl aromatic	3.6	0.16 J	ND	ND	ND	ND
toluene	alkyl aromatic	ND	1.04	ND	0.063	0.026 B	0.023 B
xylene (total)	alkyl aromatic	<u>19.0</u>	<u>4.5</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>
		22.6	5.70J	ND	0.063	0.026B	0.023B
CHLORINATED COMPOUNDS:							
chlorobenzene	aromatic halide	33.0	3.5	ND	ND	ND	ND
methylene chloride	aliphatic halide	<u>ND</u>	<u>0.29 J</u>	<u>0.004 J</u>	<u>0.007 J</u>	<u>ND</u>	<u>ND</u>
		33.0	3.79J	0.004J	0.007J	ND	ND
OTHER COMPOUNDS:							
acetone	ketone	2.9	ND	ND	0.064	0.028 B	0.017 B
2-butanone	ketone	<u>0.3 J</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>
		3.2J	ND	ND	0.064	0.028B	0.017B
-----							
2,3-dimethyl-pentane	alkane	--	0.82 T	ND	ND	ND	ND
unknown	alkane	--	12.43 T	ND	ND	0.100 T	0.093 T
unknown		--	2.08 T	ND	0.049 T	ND	ND
VOC - SUBTOTAL:		58.8	9.5	0.004	0.13	0.05	0.04
TIC - SUBTOTAL:		--	15.3	ND	0.05	0.10	0.09
VOC AND TIC TOTAL:		58.8	24.8	0.004	0.18	0.15	0.13

TABLE 6-8 (continued)

PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES FROM THE PRODUCTION AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

		(1,2,4)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2,5)
Sampling Location:		MW-1D	MW-2S	MW-3S	MW-4S	MW-5S	DUP-1
Sampling Depth:		4-6 ft	3.5-7.5 ft	4-10 ft	5-9 ft	4-8 ft	4-8 ft
Sampling Date:		5/18/88	5/17/88	5/17/88	5/17/88	5/23/88	5/23/88
Laboratory I.D. Number:		447-008	442-001	442-002	442-003	454-004	454-003

		Chemical (3)					
Semi-Volatile Organics		Compound Group					
POLYNUCLEAR AROMATIC HYDROCARBONS:							
acenaphthene	PAH	ND	ND	0.05 J	ND	ND	ND
anthracene	PAH	4.8 J	0.06 J	0.14 J	ND	ND	ND
benzo(a)anthracene	PAH	6.4 J	0.32 J	0.33 J	ND	ND	ND
benzo(b)fluoranthene	PAH	2.4 J	0.57	0.50	ND	ND	0.08 J
benzo(g,h,i)perylene	PAH	2.1 J	ND	ND	ND	ND	ND
benzo(a)pyrene	PAH	4.0 J	0.33 J	0.29 J	ND	ND	ND
chrysene	PAH	6.3 J	0.35 J	0.34 J	ND	ND	ND
fluoranthene	PAH	19.0 J	0.67	0.69	ND	ND	0.08 J
fluorene	PAH	3.6 J	ND	0.11 J	ND	ND	ND
2-methylnaphthalene	PAH	1.6 J	ND	ND	ND	ND	ND
naphthalene	PAH	3.7 J	0.21 J	ND	0.06 J	ND	ND
phenanthrene	PAH	19.0 J	0.29 J	0.46	ND	ND	0.05 J
pyrene	PAH	<u>10.0 J</u>	<u>0.80</u>	<u>0.70</u>	<u>ND</u>	<u>ND</u>	<u>0.07 J</u>
		82.90J	3.60J	3.61J	0.06J	ND	0.28J
OTHER COMPOUNDS:							
AROCLOR-1248	PCB	ND	3.30	ND	ND	ND	ND
1,2-dichlorobenzene	aromatic halide	ND	0.25 J	ND	ND	ND	ND
disulfoton	pesticide	0.17*	--	--	--	--	--
methoxychlor	pesticide	<u>2.4</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>
		2.57	3.55J	ND	ND	ND	ND

TABLE 6-8 (continued)

PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES FROM THE PRODUCTION AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

		(1,2,4)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2,5)
Sampling Location:		MW-1D	MW-2S	MW-3S	MW-4S	MW-5S	DUP-1
Sampling Depth:		4-6 ft	3.5-7.5 ft	4-10 ft	5-9 ft	4-8 ft	4-8 ft
Sampling Date:		5/18/88	5/17/88	5/17/88	5/17/88	5/23/88	5/23/88
Laboratory I.D. Number:		447-008	442-001	442-002	442-003	454-004	454-003
PHthalate Esters:							
bis(2-ethylhexyl)phthalate	DAE	ND	0.78 B	1.1 B	0.53 B	0.10 JB	0.16 JB
butyl benzyl phthalate	DAE	ND	ND	ND	ND	ND	0.10 J
diethyl phthalate	DAE	ND	ND	0.18 J	0.70	0.03 J	0.07 J
di-n-octyl phthalate	DAE	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>0.24 J</u>
		ND	0.78B	1.28JB	1.23B	0.13JB	0.57JB
ACID EXTRACTABLE COMPOUNDS:							
2-methyl phenol	alkyl phenolic	ND	ND	ND	0.11 J	ND	ND
4-methyl phenol	alkyl phenolic	<u>ND</u>	<u>0.04 J</u>	<u>ND</u>	<u>0.11 J</u>	<u>ND</u>	<u>ND</u>
		ND	0.04J	ND	0.22J	ND	ND
TIC'S							
benzene, 1,1-oxybis-	aryl ether	--	0.30 T	ND	ND	ND	ND
benzene,	aromatic halide	--	0.61 T	ND	ND	ND	ND
1-chloro-4-(trifluoromethyl)-							
1-chloromethyl benzene isomer	alkyl aromatic halide	--	ND	ND	0.55 T	ND	ND
dimethyl pyridine isomer	heterocyclic aromatic	--	ND	0.80 T	10.2 T	ND	ND
nonyl phenol isomer	alkyl phenolic	--	2.19 T	ND	ND	ND	ND
phenol, 2-(2h-benzotriazol-	amino phenolic	--	3.4 T	ND	ND	ND	ND
2-yl)-4-methyl							
pyridine, 2-ethyl-6-methyl	heterocyclic aromatic	--	ND	ND	0.53 T	ND	ND
4-tetramethylbutyl	alkyl phenolic	--	29.0 T	ND	ND	ND	ND
phenol isomer							
unknown phthalate ester	DAE	--	ND	2.50 T	ND	ND	1.66 T
unknown	alkane	--	1.49 T	ND	ND	ND	0.29 T
unknown	--	--	6.74 T	0.96 T	ND	ND	ND

TABLE 6-8 (continued)

PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES FROM THE PRODUCTION AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	(1,2,4)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2,5)
Sampling Location:	MW-1D	MW-2S	MW-3S	MW-4S	MW-5S	DUP-1
Sampling Depth:	4-6 ft	3.5-7.5 ft	4-10 ft	5-9 ft	4-8 ft	4-8 ft
Sampling Date:	5/18/88	5/17/88	5/17/88	5/17/88	5/23/88	5/23/88
Laboratory I.D. Number:	447-008	442-001	442-002	442-003	454-004	454-003
SVO - SUBTOTAL:	85.5	8.0	4.9	1.5	0.1	0.8
TIC - SUBTOTAL:	--	43.7	4.3	11.3	ND	2.0
SVO AND TIC TOTAL:	85.5	51.7	9.2	12.8	0.1	2.8

NOTES:

- (1) COMPOUND CONCENTRATIONS REPORTED IN mg/kg (ppm).  
 (2) -- = NO DATA OR NOT ANALYZED.  
     \* = AVERAGE CONCENTRATION OF TWO LABORATORY DUPLICATE SAMPLES.  
     ND = NOT DETECTED OR BELOW METHOD DETECTION LIMIT.  
     J = CONCENTRATION IS AN ESTIMATED VALUE LESS THAN THE METHOD DETECTION LIMIT.  
     B = CONTAMINANT PRESENT IN LABORATORY METHOD BLANK.  
     T = TENTATIVELY IDENTIFIED COMPOUND (TIC).  
 (3) DAE = DICARBOXYLIC ACID ESTER (PHTHALATE ESTER).  
     PAH = POLYNUCLEAR AROMATIC HYDROCARBONS.  
     PCB = POLYCHLORINATED BIPHENYL.  
 (4) APPENDIX IX ANALYSIS.  
 (5) DUPLICATE OF SAMPLE MW-5.

TABLE 6-9  
PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES FROM THE PRODUCTION AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

		(1,2)	(1,2,4)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2,5)
Sampling Location:		MW-1S	MW-1D	MW-2	MW-3	MW-4	MW-5	FH1
Sampling Date:		6/7/88	6/8/88	6/7/88	6/7/88	6/7/88	6/9/88	5/18/88
Laboratory I.D. Number:		482-002	488-007	482-004	482-001	482-003	492-001	447-010
<u>Volatile Organic Compounds</u>		<u>Chemical<sup>(3)</sup> Compound Group</u>						
BTEX COMPOUNDS:								
benzene	aromatic	64 J	ND	ND	ND	ND	ND	ND
ethyl benzene	alkyl aromatic	2600	ND	ND	ND	180 J	ND	ND
toluene	alkyl aromatic	130 J	2 J	4300	ND	39000	ND	ND
xylene (total)	alkyl aromatic	7200	ND	ND	ND	ND	ND	ND
		9994J	2J	4300	ND	39180J	ND	ND
CHLORINATED VOLATILES:								
chlorobenzene	aromatic halide	33000	ND	21000	ND	300	ND	ND
chloroform	alkyl halide	ND	ND	ND	ND	ND	ND	11
1,2-dichloroethenes (total)	aliphatic halide	ND	ND	35000	ND	ND	ND	ND
methylene chloride	aliphatic halide	ND	3 JB	ND	ND	ND	ND	ND
		33300	3JB	56,000	ND	300	ND	11
TIC's								
chloromethyl benzene isomer	alkyl aromatic halide	ND	--	ND	ND	2400 T	ND	ND
unknown		ND	--	ND	7 T	ND	ND	ND
VOC - SUBTOTAL:		42994	5	60300	ND	39480	ND	11
TIC - SUBTOTAL:		ND	--	ND	7	2400	ND	ND



TABLE 6-9 (continued)

PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES FROM THE PRODUCTION AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	(1,2)	(1,2,4)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2,5)
Sampling Location:	MW-1S	MW-1D	MW-2S	MW-3S	MW-4S	MW-5S	FH1
Sampling Date:	6/7/88	6/8/88	6/7/88	6/7/88	6/7/88	6/9/88	5/18/88
Laboratory I.D. Number:	482-002	488-007	482-004	482-001	482-003	492-001	447-010

VOC AND TIC TOTAL:	42994	5	60300	7	41880	ND	11
--------------------	-------	---	-------	---	-------	----	----

Semi-Volatile Organics

## POLYNUCLEAR AROMATIC HYDROCARBONS:

acenaphthene	PAH	ND	ND	ND	ND	12 J	ND	--
anthracene	PAH	ND	ND	ND	2 J	ND	ND	--
fluoranthene	PAH	ND	ND	ND	7 J	ND	ND	--
2-methylnaphthalene	PAH	ND	ND	9 J	ND	ND	ND	--
naphthalene	PAH	ND	ND	200	ND	11 J	ND	--
phenanthrene	PAH	ND	ND	2 J	ND	ND	ND	--
pyrene	PAH	ND	ND	ND	5 J	ND	ND	--
		ND	ND	211J	14J	23J	ND	--

## ACID EXTRACTABLE COMPOUNDS:

2-chlorophenol	phenolic halide	84	ND	98	ND	13 J	ND	--
2,4-dichlorophenol	phenolic halide	ND	ND	ND	ND	69	ND	--
2,4-dimethylphenol	alkyl phenolic	53	ND	ND	ND	13 J	ND	--
2-methylphenol	alkyl phenolic	ND	ND	34	ND	380	ND	--
4-methylphenol	alkyl phenolic	23	ND	210	ND	100	ND	--
pentachlorophenol	phenolic halide	ND	ND	32 J	ND	ND	ND	--
phenol	phenolic	12 J	ND	41	ND	13 J	ND	--
		172J	ND	415J	ND	588J	ND	--

TABLE 6-9 (continued)

PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES FROM THE PRODUCTION AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	(1,2)	(1,2,4)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2,5)
Sampling Location:	MW-1S	MW-1D	MW-2S	MW-3S	MW-4S	MW-5S	FH1
Sampling Date:	6/7/88	6/8/88	6/7/88	6/7/88	6/7/88	6/9/88	5/18/88
Laboratory I.D. Number:	482-002	486-007	482-004	482-001	482-003	492-001	447-010

## OTHER COMPOUNDS:

benzoic acid	carboxylic acid	ND	ND	ND	ND	38 J	ND	--
benzyl alcohol	aryl alcohol	ND	ND	ND	ND	22 J	ND	--
bis(2-chloroethyl)ether	aliphatic ether halide	ND	ND	ND	ND	3 J	ND	--
4-chloroaniline	aromatic amine	10 J	ND	ND	ND	ND	ND	--
		10J	ND	ND	ND	63J	ND	--
chlordane	pesticide	ND	ND	ND	ND	ND	5.54	--

## PHTHALATE ESTERS:

bis(2-ethylhexyl) phthalate	DAE	110 B	2 JB	ND	240 B	ND	170 B	--
diethyl phthalate	DAE	ND	ND	2 J	ND	1 J	ND	--
di-n-butyl phthalate	DAE	ND	1 J	16 J	ND	ND	ND	--
di-n-octyl phthalate	DAE	5 J	ND	ND	7 J	ND	ND	--
		115JB	3JB	18J	247JB	1J	170 B	

TABLE 6-9 (continued)

PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES FROM THE PRODUCTION AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	(1,2)	(1,2,4)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2,5)
Sampling Location:	MW-1S	MW-1D	MW-2S	MW-3S	MW-4S	MW-5S	FH1
Sampling Date:	6/7/88	6/8/88	6/7/88	6/7/88	6/7/88	6/9/88	5/18/88
Laboratory I.D. Number:	482-002	488-007	482-004	482-001	482-003	492-001	447-010

## CHLORINATED BENZENES:

1,2-dichlorobenzene	aromatic halide	3 J	ND	280	ND	51	ND	--
1,3-dichlorobenzene	aromatic halide	1 J	ND	ND	ND	ND	ND	--
1,4-dichlorobenzene	aromatic halide	ND	ND	6 J	ND	ND	ND	--
		4J	ND	286J	ND	51	ND	

## TIC's

benzene methanol, 2-chloro	alkyl aromatic halide	ND	--	ND	ND	24 T	ND	--
benzene,1,1'-oxybis	aryl ether	ND	--	41 T	ND	93 T	ND	--
benzenepropanoic acid	aryl carboxylic acid	ND	--	200 T	ND	ND	ND	--
benzoic acid, 2-methyl	carboxylic acid	ND	--	ND	ND	16 T	ND	--
1h-benzotriazole	cyclic amine	15 T	--	ND	ND	ND	ND	--
butane,1,1'-oxybis	alkyl ether	200 T	--	ND	ND	ND	ND	--
chlorobenzoic acid isomer	carboxylic acid halide	ND	--	ND	ND	90 T	ND	--
chloromethyl benzene isomer	alkyl aromatic halide	ND	--	ND	ND	910 T	ND	--
chlorotrifluoromethyl	aromatic amino halide	69 T	--	ND	ND	ND	ND	--
benzenamine isomer								
2,5-cyclohexadiene-1,4-dione	ketone diene	ND	--	33 T	ND	ND	ND	--
2,6-bis(1,1-dimethylethyl)	carboxylic acid	ND	--	57 T	ND	ND	ND	--
decanoic acid								
2,3-dihydro methyl 1h-indene isomer	PAH	ND	--	370 T	ND	ND	ND	--
dimethyl benzene isomer	alkyl aromatic	2080 T	--	220 T	ND	1670 T	ND	--
dimethyl phenol isomer	alkyl phenolic	ND	--	ND	ND	140 T	ND	--
dimethyl pyridine isomer	heterocyclic aromatic	148 T	--	ND	ND	182 T	ND	--
ethanone,2,2-dimethoxy-	aryl ketone	170 T	--	ND	ND	ND	ND	--
1,2-diphenyl								

TABLE 6-9 (continued)

PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES FROM THE PRODUCTION AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

		(1,2)	(1,2,4)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2,5)
Sampling Location:		MW-1S	MW-1D	MW-2S	MW-3S	MW-4S	MW-5S	FH1
Sampling Date:		6/7/88	6/8/88	6/7/88	6/7/88	6/7/88	6/9/88	5/18/88
Laboratory I.D. Number:		482-002	488-007	482-004	482-001	482-003	492-001	447-010
ethyl benzene	alkyl aromatic	790 T	--	ND	ND	120 T	ND	--
ethylmethyl benzene isomer	alkyl aromatic	ND	--	67 T	ND	ND	ND	--
furan,2-butyltetrahydro	cyclic ether	66 T	--	ND	ND	14 T	ND	--
1(3H)-isobenzofuranone	cyclic ether	16 T	--	ND	ND	ND	ND	--
2,4-pentanediol,2-methyl	alkyl diol	ND	--	160 T	ND	ND	ND	--
phenol,3-(1,1-dimethylethyl)	alkyl phenolic	85 T	--	52 T	ND	ND	ND	--
4-tetramethylbutyl phenol isomer	alkyl phenolic	ND	--	78 T	ND	ND	ND	--
unknown aromatic	aromatic	23 T	--	ND	ND	ND	ND	--
unknown acid	carboxylic acid	ND	--	520 T	ND	ND	ND	--
unknown hydrocarbon		ND	--	80 T	ND	ND	ND	--
unknown		849 T	--	523 T	ND	139 T	17 T	--
SVO - SUBTOTAL:		301	3	930	261	726	176	--
TIC - SUBTOTAL:		4511	--	2401	ND	3398	17	--
SVO AND TIC TOTAL:		4812	3	3331	261	4124	193	--

## NOTES:

- (1) COMPOUND CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ppb).
- (2) -- = NO DATA OR NOT ANALYZED.  
ND = NOT DETECTED OR BELOW METHOD OF DETECTION LIMIT.  
J = CONCENTRATION IS AN ESTIMATED VALUE LESS THAN THE METHOD DETECTION LIMIT.  
B = CONTAMINANT PRESENT IN LABORATORY METHOD BLANK.  
T = TENTATIVELY IDENTIFIED COMPOUND (TIC).
- (3) DAE = DICARBOXYLIC ACID ESTER.  
PAH = POLYNUCLEAR AROMATIC HYDROCARBONS.
- (4) APPENDIX IX ANALYSIS.
- (5) FIRE HYDRANT WATER SAMPLE.

TABLE 6-10  
SUMMARY OF INORGANIC CONSTITUENTS  
IN SOIL AND GROUND WATER SAMPLES  
PRODUCTION AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Analyte	Media	Number of Analyses	Number of Positive Results	Range	Average
Aluminum	Soil	6	6	5210-7650 ppm	6272 ppm
	Ground Water	--	--	--	--
Antimony	Soil	8	1	<12.6-<19.4 ppm	<15.7 ppm
	Ground Water	--	--	--	--
Arsenic	Soil	6	6	2.9-8.2 ppm	4.4 ppm
	Ground Water	12	5	<2.8-609 ppb	<161 ppb
Barium	Soil	6	6	28.3-606 ppm	146 ppm
	Ground Water	-	-	-	-
Beryllium	Soil	6	0	<0.13-<0.19 ppm	<0.16 ppm
	Ground Water	-	-	-	-
Cadmium	Soil	6	1	<1.1-2.6 ppm	<1.5 ppm
	Ground Water	12	4	<3.9-10 ppb	<4.2 ppb
Calcium	Soil	6	6	610-6480 ppm	2454 ppm
	Ground Water	-	-	-	-
Chromium	Soil	6	6	7.97-456 ppm	85.9 ppm
	Ground Water	18	9	<4.4-<98 ppb	<24.1 ppb
Cobalt	Soil	6	6	3.41-9.22 ppm	5.1 ppm
	Ground Water	-	-	-	-
Copper	Soil	6	6	7.17-221 ppm	76.6 ppm
	Ground Water	-	-	-	-
Iron	Soil	6	6	11100-76600 ppm	22683 ppm
	Ground Water	6	6	4260-71500 ppb	22486 ppb

TABLE 6-10 (continued)  
SUMMARY OF INORGANIC CONSTITUENTS  
IN SOIL AND GROUND WATER SAMPLES  
PRODUCTION AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Analyte	Media	Number of Analyses	Number of Positive Results	Range	Average
Lead	Soil	6	6	5.3-197 ppm	58.3 ppm
	Ground Water	18	16	<1.7-247 ppb	<63.3 ppb
Magnesium	Soil	6	6	1410-1970 ppm	1682 ppm
	Ground Water	-	-	-	-
Manganese	Soil	6	6	118-3850 ppm	790 ppm
	Ground Water	12	11	<6.5-5050 ppb	<1412 ppb
Mercury	Soil	6	1	<0.05-0.18 ppm	0.10 ppm
	Ground Water	-	-	-	-
Nickel	Soil	6	6	6.26-12.4 ppm	9.9 ppm
	Ground Water	-	-	-	-
Potassium	Soil	6	6	446-913 ppm	587 ppm
	Ground Water	-	-	-	-
Selenium	Soil	6	1	<0.26-1.03 ppm	<0.44 ppm
	Ground Water	-	-	-	-
Silver	Soil	6	5	0.42-2.46 ppm	<0.89 ppm
	Ground Water	-	-	-	-
Sodium	Soil	6	6	251-418 ppm	328 ppm
	Ground Water	-	-	-	-
Thallium	Soil	6	0	<0.52-<0.78 ppm	<0.65 ppm
	Ground Water	-	-	-	-
Vanadium	Soil	6	6	11.5-27.4 ppm	20.0 ppm
	Ground Water	-	-	-	-

TABLE 6-10 (continued)  
SUMMARY OF INORGANIC CONSTITUENTS  
IN SOIL AND GROUND WATER SAMPLES  
PRODUCTION AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Analyte	Media	Number of Analyses	Number of Positive Results	Range	Average
Zinc	Soil	6	6	34.4-444 ppm	127 ppm
	Ground Water	12	3	<20-<43000 ppb	<12736 ppb
Tin	Soil	1	0	<125 ppm	<125 ppm
	Ground Water	-	-	-	-
Cyanide	Soil	6	1	<0.54-23.9 ppm	<5.2 ppm
	Ground Water	6	2	<10.0-15.5 ppb	<10.9 ppb
Flouride	Soil	1	1	122.7 ppm	122.7 ppm
	Ground Water	1	1	760 ppb	760 ppb
Sulfide	Soil	1	1	456 ppm	456 ppm
	Ground Water	1	0	<1000 ppb	<1000 ppb

**NOTES:**

-- = NO DATA OR NOT ANALYZED.

TABLE 6-11  
PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES  
FROM THE WASTE WATER TREATMENT AREA  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

		(1,2,4)	(1,2)	(1,2)
Sampling Location:		MW-7S	MW-8S	MW-9S
Sampling Depth:		5-7 ft	5-7 ft	2-6 ft
Sampling Date:		5/19/88	5/18/88	5/23/88
Laboratory I.D. Number:		450-001	447-001	454-002
<hr/>				
	Chemical (3)			
<u>Volatile Organic Compounds</u>	<u>Compound Group</u>	F	I	L
<hr/>				
BTEX:				
toluene	alkyl aromatic	0.003 J	ND	0.023 B
<hr/>				
OTHER COMPOUNDS:				
acetone	ketone	0.015	ND	0.033 B
2-butanone	ketone	<u>0.003 JB</u>	<u>ND</u>	<u>ND</u>
		0.018JB	ND	0.033B
<hr/>				
CHLORINATED COMPOUNDS:				
1,2-dichloroethane	aliphatic halide	0.002 J	ND	ND
1,1,2,2-tetrachloroethane	aliphatic halide	0.013	ND	ND
1,1,1-trichloroethane	aliphatic halide	ND	0.009	ND
trichloroethylene	aliphatic halide	<u>0.012</u>	<u>ND</u>	<u>ND</u>
-----		0.027J	0.009	ND
<hr/>				
unknown alkane	alkane	--	ND	0.116 T
<hr/>				
VOC - SUBTOTAL		0.05	0.01	0.06
TIC - SUBTOTAL		--	ND	0.12
<hr/>				
VOC + TIC - TOTAL		0.05	0.01	0.17
<hr/>				
<u>Semi-Volatile Compounds</u>				
<hr/>				
POLYNUCLEAR AROMATIC HYDROCARBONS:				
fluoranthene	PAH	0.83 J	0.031 J	ND
phenanthrene	PAH	ND	0.017 J	ND
pyrene	PAH	<u>0.67 J</u>	<u>ND</u>	<u>ND</u>
		1.50 J	0.048 J	ND



TABLE 6-11  
PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES  
FROM THE WASTE WATER TREATMENT AREA  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

Sampling Location:	(1,2,4) MW-7S	(1,2) MW-8S	(1,2) MW-9S
Sampling Depth:	5-7 ft	5-7 ft	2-6 ft
Sampling Date:	5/19/88	5/18/88	5/23/88
Laboratory I.D. Number:	450-001	447-001	454-002

PESTICIDES:

alpha-chlordane	pesticide	0.26	--	--
gamma-chlordane	pesticide	0.18	--	--
dieldrin	pesticide	0.017	ND	ND
4,4'-DDE	pesticide	0.085	ND	ND
4,4'-DDD	pesticide	<u>0.13</u>	<u>ND</u>	<u>ND</u>
		0.672	ND	ND

PHthalate ESTERS:

bis(2-ethyl hexyl)phthalate	DAE	ND	0.13 JB	0.87 B
butyl benzyl phthalate	DAE	ND	0.41	ND
diethyl phthalate	DAE	ND	ND	1.3
dimethyl phthalate	DAE	<u>ND</u>	<u>0.26 J</u>	<u>ND</u>
		ND	0.80JB	2.17B

OTHER COMPOUNDS:

OCDD	dioxin	0.00022	--	--
bicyclo(4.2.0) octa-1,3,5-triene	triene	--	0.37 T	ND
unknown		--	0.46 T	3.9 T

SVO - SUBTOTAL	2.17	0.85	2.17
TIC - SUBTOTAL	--	0.83	3.90
SVO + TIC - TOTAL	2.17	1.68	6.07

NOTES:

- (1) COMPOUND CONCENTRATIONS REPORTED IN mg/kg (ppm).
- (2) -- = NO DATA OR NOT ANALYZED.  
 ND = NOT DETECTED OR BELOW METHOD DETECTION LIMIT.  
 J = CONCENTRATION IS AN ESTIMATED VALUE LESS THAN THE METHOD DETECTION LIMIT.  
 B = CONTAMINANT PRESENT IN LABORATORY METHOD BLANK.  
 T = TENTATIVELY IDENTIFIED COMPOUND (TIC).
- (3) DAE = DICARBOXYLIC ACID ESTER.  
 PAH = POLYNUCLEAR AROMATIC HYDROCARBONS.
- (4) APPENDIX IX ANALYSIS.

TABLE 6-12  
SUMMARY OF INORGANIC CONSTITUENTS  
IN SOIL AND GROUND WATER SAMPLES  
WASTE WATER TREATMENT AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Analyte	Media	Number of Analyses	Number of Positive Results	Range	Average
Aluminum	Soil	3	3	2970-6790	5383 ppm
	Ground Water	--	--	--	--
Antimony	Soil	3	0	<12.6-<15.2 ppm	<13.6 ppm
	Ground Water	--	--	--	--
Arsenic	Soil	3	1	0.64-7.70 ppm	<3 ppm
	Ground Water	2	2	4.0-10.0	<7.0 ppb
Barium	Soil	3	3	25.6-127 ppm	67.5 ppm
	Ground Water	-	-	-	-
Beryllium	Soil	3	0	<0.13-<0.15 ppm	<0.14 ppm
	Ground Water	-	-	-	-
Cadmium	Soil	3	0	<1.0-<1.3 ppm	<1.1 ppm
	Ground Water	2	0	<4.7 ppb	<4.7 ppb
Calcium	Soil	3	3	897-5230 ppm	2626 ppm
	Ground Water	-	-	-	-
Chromium	Soil	3	3	4.40-135 ppm	49.77 ppm
	Ground Water	6	4	7.9-<62.4 ppb	<18.7 ppb
Cobalt	Soil	3	3	1.64-5.40 ppm	3.72 ppm
	Ground Water	-	-	-	-
Copper	Soil	3	3	10.7-115 ppm	56.0 ppm
	Ground Water	-	-	-	-
Iron	Soil	3	3	3910-14400 ppm	9277 ppm
	Ground Water	4	4	2260-35800 ppb	15460 ppb

TABLE 6-12 (Continued)  
SUMMARY OF INORGANIC CONSTITUENTS  
IN SOIL AND GROUND WATER SAMPLES  
WASTE WATER TREATMENT AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Analyte	Media	Number of Analyses	Number of Positive Results	Range	Average
Lead	Soil	3	3	7.97-265 ppm	95.0 ppm
	Ground Water	6	6	1.8-24.6 ppb	7.6 ppb
Magnesium	Soil	3	3	944-1560 ppm	1315 ppm
	Ground Water	-	-	-	-
Manganese	Soil	3	3	41.3-185 ppm	130.1 ppm
	Ground Water	5	5	1160-5470 ppb	3002 ppb
Mercury	Soil	3	1	<0.05-0.30 ppm	<0.13 ppm
	Ground Water	-	-	-	-
Nickel	Soil	3	3	2.71-10.6 ppm	6.79 ppm
	Ground Water	-	-	-	-
Potassium	Soil	3	3	426-1090 ppm	695 ppm
	Ground Water	-	-	-	-
Selenium	Soil	3	1	<0.26-0.40 ppm	<0.32 ppm
	Ground Water	-	-	-	-
Silver	Soil	3	1	<0.04-1.95 ppm	<0.80 ppm
	Ground Water	-	-	-	-
Sodium	Soil	3	3	161-411 ppm	303 ppm
	Ground Water	-	-	-	-
Thallium	Soil	3	0	<0.53-<0.60 ppm	<0.57 ppm
	Ground Water	-	-	-	-
Vanadium	Soil	3	3	4.46-13.0 ppm	10.15 ppm
	Ground Water	-	-	-	-

TABLE 6-12 (Continued)  
SUMMARY OF INORGANIC CONSTITUENTS  
IN SOIL AND GROUND WATER SAMPLES  
WASTE WATER TREATMENT AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Analyte	Media	Number of Analyses	Number of Positive Results	Range	Average
Zinc	Soil	3	3	38.7-320 ppm	156.6 ppm
	Ground Water	2	1	1000-<1510 ppb	<1255 ppb
Tin	Soil	1	0	<126 ppm	<126 ppm
	Ground Water	-	-	-	-
Cyanide	Soil	3	1	<0.54-0.69 ppm	<0.59
	Ground Water	4	0	<10 ppb	<10 ppb
Flouride	Soil	1	1	159 ppm	159 ppm
	Ground Water	1	1	540 ppb	540 ppb
Sulfide	Soil	1	0	<1.0 ppm	<1.0 ppm
	Ground Water	1	0	<1000 ppb	<1000 ppb

NOTES:

-- = No data or not analyzed

TABLE 6-13  
PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES  
FROM THE WASTE WATER TREATMENT AREA  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

	(1,2,4)	(1,2)	(1,2)	(1,2,5)
Sampling Location:	MW-7S	MW-8S	MW-9S	DUP
Sampling Date:	6/8/88	6/8/88	6/8/88	6/8/88
Laboratory I.D. Number:	488-006	488-002	488-001	488-003

<u>Volatile Organic Compounds</u>	<u>Chemical (3) Compound Group</u>				
BTEX COMPOUNDS:					
toluene	alkyl aromatic	ND	ND	ND	3 J
xylenes (total)	alkyl aromatic	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>6</u>
		ND	ND	ND	9J
CHLORINATED COMPOUNDS:					
1,2-dichloropropane	aliphatic halide	ND	83 JB	ND	ND
methylene chloride	aliphatic halide	ND	10000	4 JB	50 B
1,1,1-trichloroethane	aliphatic halide	<u>ND</u>	<u>470</u>	<u>ND</u>	<u>4 J</u>
		ND	10553JB	4JB	54JB
OTHER COMPOUNDS:					
acetone	ketone	ND	ND	12 B	8 JB
VOC - SUBTOTAL					
		ND	10553	16	71
TIC - SUBTOTAL					
		ND	ND	ND	ND
VOC + TIC - TOTAL					
		ND	10553	16	71

Semi-Volatile Organics

POLYNUCLEAR AROMATIC HYDROCARBONS:

acenaphthene	PAH	ND	2 J	ND	ND
anthracene	PAH	ND	1 J	ND	ND
fluoranthene	PAH	ND	5 J	ND	ND
fluorene	PAH	ND	1 J	ND	ND
phenanthrene	PAH	ND	5 J	ND	ND
pyrene	PAH	<u>ND</u>	<u>4 J</u>	<u>ND</u>	<u>ND</u>
		ND	18J	ND	ND

TABLE 6-13  
PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES  
FROM THE WASTE WATER TREATMENT AREA  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

Sampling Location:	(1,2,4) MW-7S	(1,2) MW-8S	(1,2) MW-9S	(1,2,5) DUP
Sampling Date:	6/8/88	6/8/88	6/8/88	6/8/88
Laboratory I.D. Number:	488-006	488-002	488-001	488-003

PHthalate Esters:

bis(2-ethyl hexyl)phthalate	DAE	4 JB	43	3 J	2 J
-----------------------------	-----	------	----	-----	-----

TICs

9-octadecen-1-ol (z)	alcohol	--	55 T	140 T	140 T
unknown	carboxylic acid	--	9 T	ND	ND
unknown	alkane	--	19 T	ND	ND
unknown	aromatic	--	52 T	50 T	20 T
unknown	aromatic	--	49 T	35 T	21 T

SVO - SUBTOTAL	4	61	3	2
TIC - SUBTOTAL	--	184	225	181
SVO + TIC - TOTAL	4	245	228	183

NOTES:

- (1) COMPOUND CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ppb).
- (2) -- = NO DATA OR NOT ANALYZED.  
ND = NOT DETECTED OR BELOW METHOD DETECTION LIMIT.  
J = CONCENTRATION IS AN ESTIMATED VALUE LESS THAN THE METHOD DETECTION LIMIT.  
B = CONTAMINANT PRESENT IN LABORATORY METHOD BLANK.  
T = TENTATIVELY IDENTIFIED COMPOUND (TIC).
- (3) DAE = DICARBOXYLIC ACID ESTER.  
PAH = POLYNUCLEAR AROMATIC HYDROCARBONS.
- (4) APPENDIX IX ANALYSIS.
- (5) DUPLICATE OF SAMPLE MW-9.

TABLE 6-14

PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES FROM THE WARWICK AREA  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

		(1,2,4)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2,4)
Sampling Location:		MW-6S	RS-1	RS-2	RS-3	RS-4	RS-5
Sampling Depth:		3-5 ft	1 ft	1 ft	1 ft	1 ft	1 ft
Sampling Date:		5/18/88	5/18/88	5/18/88	5/18/88	5/18/88	5/19/88
Laboratory I.D. Number:		447-007	447-002	447-003	447-004	447-005	450-002

<u>Volatile Organic Compounds</u>	<u>Chemical<sup>(3)</sup> Compound Group</u>						
BTX COMPOUNDS:							
ethyl benzene	alkyl aromatic	ND	ND	0.001 J	ND	ND	ND
toluene	alkyl aromatic	ND	0.001 J	0.007	ND	ND	0.005 JB
		ND	0.001J	0.008J	ND	ND	0.005JB
CHLORINATED VOLATILES:							
chlorobenzene	aromatic halide	ND	ND	ND	ND	ND	0.0006 J
methylene chloride	aliphatic halide	ND	ND	0.005 J	0.005 J	0.004 J	ND
tetrachloroethylene	aliphatic halide	ND	0.002 J	0.013	ND	ND	ND
1,1,1-trichloroethane	aliphatic halide	ND	0.004 J	0.002 JB	ND	ND	ND
trichloroethylene	aliphatic halide	ND	ND	ND	ND	ND	0.005 J
		ND	0.006J	0.020JB	0.005J	0.004J	0.0056J

TABLE 6-14 (continued)

PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES FROM THE WARWICK AREA  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

		(1,2,4)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2,4)
Sampling Location:		MW-6S	RS-1	RS-2	RS-3	RS-4	RS-5
Sampling Depth:		3-5 ft	1 ft	1 ft	1 ft	1 ft	1 ft
Sampling Date:		5/18/88	5/18/88	5/18/88	5/18/88	5/18/88	5/19/88
Laboratory I.D. Number:		447-007	447-002	447-003	447-004	447-005	450-002
OTHER COMPOUNDS:							
acetone	ketone	ND	ND	0.009	ND	ND	ND
2-butanone	ketone	0.003 JB	ND	ND	ND	ND	0.002 JB
		0.003JB	ND	0.009	ND	ND	0.002JB
TIC							
-----							
benzene, 1-chloro-4-trifluoromethyl	alkyl aromatic halide	--	ND	0.019 T	ND	ND	ND
unknown		--	ND	0.006 T	ND	ND	ND
VOC - SUBTOTAL		0.003	0.007	0.037	0.005	0.004	0.013
TIC - SUBTOTAL		--	ND	0.025	ND	ND	ND
VOC + TIC - TOTAL		0.003	0.007	0.062	0.005	0.004	0.013

Semi-Volatile Organics

## POLYNUCLEAR AROMATIC HYDROCARBONS:

acenaphthene	PAH	ND	0.02 J	0.57	0.15 J	ND	ND
acenaphthylene	PAH	ND	0.009 J	0.074 J	0.046 J	0.018 J	ND
anthracene	PAH	ND	0.059 J	0.77	0.5	0.11 J	ND
benzo(a)anthracene	PAH	ND	0.36 J	3.5	1.5	0.59	ND
benzo(b)fluoranthene	PAH	ND	0.4	3.3	1.2	0.44	ND



TABLE 6-14 (continued)

PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES FROM THE WARWICK AREA  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

		(1,2,4)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2,4)
Sampling Location:		MW-6S	RS-1	RS-2	RS-3	RS-4	RS-5
Sampling Depth:		3-5 ft	1 ft	1 ft	1 ft	1 ft	1 ft
Sampling Date:		5/18/88	5/18/88	5/18/88	5/18/88	5/18/88	5/19/88
Laboratory I.D. Number:		447-007	447-002	447-003	447-004	447-005	450-002
benzo(k)fluoranthene		PAH	ND	ND	1.2	ND	ND
benzo(g,h,i)perylene		PAH	ND	0.2 J	1.6	0.27 J	ND
benzo(a)pyrene		PAH	ND	0.37 J	3.2	1.2	0.61
chrysene		PAH	ND	0.41	3.7	1.4	0.65
fluoranthene		PAH	0.1 J	0.71	6.5	3.1	1
fluorene		PAH	ND	0.02 J	0.4 J	0.21 J	ND
indeno(1,2,3,c,d)pyrene		PAH	ND	0.19 J	1.5	0.52	0.24 J
2-methylnaphthalene		PAH	ND	ND	0.049 J	0.029 J	ND
naphthalene		PAH	ND	ND	0.078 J	0.051 J	0.028 J
phenanthrene		PAH	0.062 J	0.31 J	3.8	2.2	0.57
pyrene		PAH	<u>0.062 J</u>	<u>0.69</u>	<u>6.5</u>	<u>2.9</u>	<u>1.5</u>
			0.224J	3.748J	35.541J	16.706J	6.026J
PTHALATE ESTERS:							
bis(2-ethyl hexyl)phthalate		DAE	ND	0.11 JB	0.41 JB	0.12 JB	0.24 JB
butyl benzyl phthalate		DAE	ND	ND	ND	0.2 J	ND
diethyl phthalate		DAE	ND	ND	0.036 J	ND	ND
di-n-butyl phthalate		DAE	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>0.098 J</u>
			ND	0.11J	0.446JB	0.32JB	0.338JB
OTHER COMPOUNDS:							
aroclor-1254		PCB	ND	ND	ND	ND	0.98
bis(2-chloroethyl)ether		alkoxy ether	ND	ND	0.084 J	ND	ND
chlordane		pesticide	ND	ND	ND	0.29	0.59
4-chloroaniline		aryl amine halide	ND	ND	0.26 J	ND	0.17 J
2-chlorophenol		phenolic halide	ND	ND	ND	ND	3.7 J

TABLE 6-14 (continued)

PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES FROM THE WARWICK AREA  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

		(1,2,4)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2,4)
Sampling Location:		MW-6S	RS-1	RS-2	RS-3	RS-4	RS-5
Sampling Depth:		3-5 ft	1 ft	1 ft	1 ft	1 ft	1 ft
Sampling Date:		5/18/88	5/18/88	5/18/88	5/18/88	5/18/88	5/19/88
Laboratory I.D. Number:		447-007	447-002	447-003	447-004	447-005	450-002
dibenzofuran	ACE	ND	ND	0.15 J	0.1 J	0.014 J	ND
disulfoton	pesticide	ND	--	--	--	--	0.06
isophorone	cyclic ketone	0.099 J	ND	ND	ND	ND	ND
OCDD	dioxin	ND	--	--	--	--	0.00024
		0.99J	ND	0.494J	0.39J	1.754J	6.26024J
-----							
11H-benzo(a)fluorene	PAH	--	0.17 T	ND	ND	ND	--
11H-benzo(b)fluorene	PAH	--	ND	ND	ND	ND	--
benzenamine, 2-chloro-5-(trifluoromethyl)	aromatic amino halide	--	ND	4.5 T	ND	ND	--
benzenamine, 4-chloro-3-(trifluoromethyl)	aromatic amino halide	--	ND	1.4 T	ND	ND	--
benzene, 1-chloro-4-(trifluoromethyl)	alkyl aromatic halide	--	ND	0.4 T	ND	ND	--
2,5-cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)	cyclic diene	--	ND	ND	ND	1.1 T	--
methyl pyrene isomer	PAH	--	ND	ND	0.37 T	ND	--
phenol, 2,4-bis-(1,1-dimethylethyl)	alkoxy aromatic	--	ND	0.7 T	ND	ND	--
phenol, dimethyl-phosphate (3:1)	alkyl phenolic	--	ND	ND	ND	1.6 T	--
trimethyl benzene isomer	alkyl aromatic	--	ND	0.52 T	ND	ND	--
unknown PAH	PAH	--	0.16 T	ND	1.91 T	ND	--
unknown phthalate ester	DAE	--	2.1 T	ND	ND	ND	--
unknown phenol		--	ND	ND	ND	0.65 T	--
unknown	alkane	--	0.42 T	1.87 T	1.55 T	0.81 T	--
unknown		--	1.16 T	4.1 T	1.09 T	4.07 T	--

TABLE 6-14 (continued)

PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES FROM THE WARWICK AREA  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

	(1,2,4)	(1,2)	(1,2)	(1,2)	(1,2)	(1,2,4)
Sampling Location:	MW-6S	RS-1	RS-2	RS-3	RS-4	RS-5
Sampling Depth:	3-5 ft	1 ft	1 ft	1 ft	1 ft	1 ft
Sampling Date:	5/18/88	5/18/88	5/18/88	5/18/88	5/18/88	5/19/88
Laboratory I.D. Number:	447-007	447-002	447-003	447-004	447-005	450-002
SVO - SUBTOTAL	0.32	3.86	36.48	17.42	8.12	8.95
TIC - SUBTOTAL	--	4.01	13.49	4.92	8.23	--
SVO + TIC - TOTAL	0.32	7.87	49.97	22.34	16.35	8.95

NOTES:

- (1) COMPOUND CONCENTRATIONS REPORTED IN mg/kg (ppm).  
 (2) -- = NO DATA OR NOT ANALYZED.  
     ND = NOT DETECTED OR BELOW METHOD DETECTION LIMIT.  
     J = CONCENTRATION IS AN ESTIATED VALUE LESS THAN THE METHOD DETECTION LIMIT.  
     B = CONTAMINANT PRESENT IN LABORATORY METHOD BLANK.  
     T = TENTATIVELY IDENTIFIED COMPOUND (TIC).  
 (3) DAE = DICARBOXYLIC ACID ESTER.  
     ACE = AROMATIC CYCLIC ETHER.  
     PAH = POLYNUCLEAR AROMATIC HYDROCARBON.  
     PCB = POLYCHLORINATED BIPHENYL.  
 (4) APPENDIX IX ANALYSIS.

TABLE 6-15  
SUMMARY OF INORGANIC CONSTITUENTS  
IN SOIL AND GROUND WATER SAMPLES  
WARWICK AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Analyte	Media	Number of Analyses	Number of Positive Results	Range	Average
Aluminum	Soil	6	6	2960-10900 ppm	6480 ppm
	Ground Water	--	--	--	--
Antimony	Soil	8	2	<12.9-137 ppm	<32.1 ppm
	Ground Water	--	--	--	--
Arsenic	Soil	8	7	1.3-31 ppm	7 ppm
	Ground Water	1	0	<2.8 ppb	<2.8 ppb
Barium	Soil	7	7	30.2-622 ppm	155.6 ppm
	Ground Water	-	-	-	-
Beryllium	Soil	8	2	<0.13-<2.2 ppm	<0.56 ppm
	Ground Water	--	--	--	--
Cadmium	Soil	8	1	<1.1-14 ppm	<3.9 ppm
	Ground Water	2	0	<4.7-<9.3 ppb	<7 ppb
Calcium	Soil	6	6	598-2240 ppm	1710 ppm
	Ground Water	-	-	-	-
Chromium	Soil	8	8	10.6-407 ppm	79.7 ppm
	Ground Water	3	1	<9.4-<15 ppb	<10.8 ppb
Cobalt	Soil	6	6	3.41-4.70 ppm	4.11 ppm
	Ground Water	-	-	-	-
Copper	Soil	7	7	18.6-574 ppm	122.7 ppm
	Ground Water	-	-	-	-
Iron	Soil	7	7	12100-64500 ppm	21214 ppm
	Ground Water	1	1	15000 ppb	15000 ppb

TABLE 6-15 (Continued)  
SUMMARY OF INORGANIC CONSTITUENTS  
IN SOIL AND GROUND WATER SAMPLES  
WARWICK AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Analyte	Media	Number of Analyses	Number of Positive Results	Range	Average
Lead	Soil	8	8	5.2-383 ppm	83.2 ppm
	Ground Water	3	1	<9.4-<15 ppb	<10.3 ppb
Magnesium	Soil	7	7	1020-5760 ppm	2106 ppm
	Ground Water	-	-	-	-
Manganese	Soil	7	7	146-971 ppm	331 ppm
	Ground Water	2	2	18-963 ppb	491 ppb
Mercury	Soil	8	7	<0.12-38 ppm	<5.0 ppm
	Ground Water	-	-	-	-
Nickel	Soil	8	6	7.54-<30 ppm	13.1 ppm
	Ground Water	-	-	-	-
Potassium	Soil	6	6	365-632 ppm	464 ppm
	Ground Water	-	-	-	-
Selenium	Soil	8	6	<0.30-1.5 ppm	<0.6 ppm
	Ground Water	-	-	-	-
Silver	Soil	8	1	0.43-<8.0 ppm	<1.5 ppm
	Ground Water	-	-	-	-
Sodium	Soil	6	6	211-387 ppm	264 ppm
	Ground Water	-	-	-	-
Thallium	Soil	6	0	<0.57->0.95 ppm	<0.67 ppm
	Ground Water	-	-	-	-
Vanadium	Soil	7	7	13.8-101 ppm	28.3 ppm
	Ground Water	-	-	-	-

TABLE 6-15 (Continued)  
SUMMARY OF INORGANIC CONSTITUENTS  
IN SOIL AND GROUND WATER SAMPLES  
WARWICK AREA  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Analyte	Media	Number of Analyses	Number of Positive Results	Range	Average
Zinc	Soil	8	8	94.2-24600 ppm	5166.5 ppm
	Ground Water	2	1	5360-<7630 ppb	<6495 ppb
Tin	Soil	2	0	<126 ppm-<173 ppm	<150 ppm
	Ground Water	-	-	-	-
Cyanide	Soil	6	4	<0.55-1.38 ppm	<0.89 ppm
	Ground Water	1	0	<10.0 ppb	<10.0 ppb
Flouride	Soil	2	2	121-165.7 ppm	143.4 ppm
	Ground Water	1	1	480 ppb	480 ppb
Sulfide	Soil	2	0	<1.0 ppm	<1.0 ppm
	Ground Water	1	0	<1000 ppb	<1000 ppb

NOTES:

-- = No data or not analyzed.

TABLE 6-16  
PRELIMINARY INVESTIGATION SUMMARY OF ORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES  
FROM THE WARWICK AREA  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

Sampling Location:	(1,2,3)
Sampling Date:	MW-6S
Laboratory I.D. Number:	6/8/88
	488-004

<u>Volatile Organic Compounds</u>	Chemical <sup>(3)</sup> <u>Compound Group</u>
methylene chloride	aliphatic halide 5 B
toluene	alkyl aromatic 4 J
VOC - TOTAL	9 JB
 <u>Semi-Volatile Organcis</u>	
bis(2-ethylhexyl)phthalate	DAE 2 JB
methoxychlor	pesticide 1.4
SVO - TOTAL	3.4 JB

NOTES:

- (1) COMPOUND CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ppb).  
 (2) ND = NOT DETECTED OR BELOW METHOD DETECTION LIMIT.  
     J = CONCENTRATION IS AN ESTIMATED VALUE LESS THAN THE METHOD DETECTION LIMIT.  
     B = CONTAMINANT PRESENT IN LABORATORY METHOD BLANK.  
 (3) APPENDIX IX ANALYSIS.

TABLE 6-17  
FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN OFF-SITE  
SOIL SAMPLES COLLECTED ON 23 JULY 1986  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	Sample Number						
	1	2	3	4	5	6	7
<u>Metals (ppm)</u>							
Zinc	25.1	105.2	19.9	33.3	32.6	40.2	65.5
<u>Volatile Organic Compounds (ppm)</u>							
BTEX COMPOUNDS:							
benzene	ND	ND	ND	ND	ND	0.7	ND
toluene	0.6	ND	ND	0.6	0.7	2	0.9
ethylbenzene	ND	ND	ND	ND	ND	0.5	ND
xylene	<u>ND</u> 0.6	<u>ND</u> ND	<u>ND</u> ND	<u>0.9</u> 1.5	<u>1</u> 1.7	<u>3</u> 6.2	<u>2</u> 2.9
CHLORINATED VOLATILES:							
chloroform	8	0.5	2	6	6	40	6
bromodichloromethane	ND	ND	ND	ND	ND	1	ND
1,1,1-trichloroethane	ND	ND	ND	ND	ND	0.8	ND
carbon Tetrachloride	ND	ND	ND	ND	ND	0.5	ND
dichloromethane (methylene chloride)	20	2	1	10	8	70	10
1,2-dichloroethene	<u>ND</u> 28	<u>ND</u> 2.5	<u>ND</u> 3	<u>ND</u> 16	<u>ND</u> 14	<u>0.8</u> 113.1	<u>ND</u> 16
<u>Polynuclear Aromatic Hydrocarbons (ppm)</u>							
naphthalene	ND	ND	0.018	0.091	ND	ND	0.034
acenaphthylene	ND	0.092	0.057	0.68	0.043	0.023	0.25
acenaphthene	ND	0.18	0.051	ND	ND	ND	ND
fluorene	ND	0.33	0.11	0.69	ND	ND	0.033
phenanthrene	0.066	4.5	2.0	5.8	0.24	0.25	0.35
anthracene	ND	0.55	0.13	4.9	ND	ND	0.056
fluoranthene	0.19	6.7	2.3	14.0	0.49	0.46	0.69
pyrene	0.14	4.7	1.4	12.0	0.37	0.36	0.55
benzo(a)anthracene	0.074	1.8	0.52	3.1	0.22	0.18	0.4
chrysene	0.053	2.3	3.7	6.3	0.14	0.12	0.33
benzo(b)fluoranthene	ND	1.8	0.56	4.2	0.18	ND	0.58
benzo(k)fluoranthene	ND	3.2	0.47	2.7	0.18	0.25	0.35
benzo(a)pyrene	ND	3.6	0.55	4.0	0.23	ND	0.68
ideno(1,2,3)pyrene	ND	ND	0.6	1.5	ND	ND	ND
benzo(g,h,i)perylene	<u>ND</u> 0.523	<u>ND</u> 29.752	<u>0.44</u> 12.906	<u>1.3</u> 61.261	<u>ND</u> 2.093	<u>ND</u> 1.643	<u>ND</u> 4.247



TABLE 6-17 (continued)  
FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN OFF-SITE  
SOIL SAMPLES COLLECTED ON 23 JULY 1986  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	Sample Number						
	1	2	3	4	5	6	7
Others (ppm)							
Dacthal	0.91	ND	ND	ND	ND	ND	ND
p-cresol	ND	ND	ND	ND	ND	ND	ND
phenyl ether	ND	ND	ND	ND	ND	ND	ND
biphenyl	ND	ND	0.048	0.95	ND	0.034	ND
Tinuvin 327	ND	11.0	ND	ND	ND	2.1	0.11
Tinuvin 328	0.11	1.5	ND	ND	ND	0.42	0.036
Prometon	ND	ND	ND	ND	ND	ND	ND
	1.02	12.5	0.048	0.95	ND	2.554	0.146

Notes:

ND = not detected.

ppm = parts per million.

Analyses performed by Rhode Island Department of Health, Division of Laboratories.

Table based on data reported by Versar, Inc. (1988).

TABLE 6-18  
FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN OFF-SITE  
SOIL SAMPLES COLLECTED ON 12 NOVEMBER 1986  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	Sample Number						
	2A	A	B	C	D	RT	OT
<u>Metals (ppm)</u>							
Zinc	34.1	NA	151.0	232.0	88.7	NA	NA
<u>Volatile Organics (ppm)</u>							
	ND	NA	ND	ND	ND	NA	NA
<u>Polynuclear Aromatic Hydrocarbons (ppm)</u>							
naphthalene	ND	ND	ND	ND	ND	ND	ND
acenaphthylene	ND	ND	0.18	ND	ND	ND	ND
acenaphthene	ND	ND	ND	ND	ND	ND	ND
fluorene	ND	ND	ND	ND	ND	ND	ND
phenanthrene	3.4	ND	2.3	0.52	ND	ND	ND
anthracene	0.4	ND	0.3	ND	ND	ND	ND
fluoranthene	5.8	0.013	4.1	0.82	ND	ND	ND
pyrene	5.8	0.01	3.5	0.82	ND	ND	ND
benzo(a)anthracene	6.8	ND	2.4	0.72	ND	ND	ND
chrysene	4.7	ND	2.0	0.48	ND	ND	ND
benzo(b)fluoranthene	ND	ND	3.2	ND	ND	ND	ND
benzo(k)fluoranthene	1.5	ND	1.3	ND	ND	ND	ND
benzo(a)pyrene	14.0	ND	5.3	1.3	ND	ND	ND
ideno(1,2,3)pyrene	6.6	ND	2.4	ND	ND	ND	ND
dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND
benzo(g,h,i)perylene	<u>5.7</u>	<u>ND</u>	<u>2.5</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>
	54.7	0.023	29.48	4.66	ND	ND	ND

TABLE 6-18 (continued)  
FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN OFF-SITE  
SOIL SAMPLES COLLECTED ON 12 NOVEMBER 1986  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	Sample Number						
	2A	A	B	C	D	RT	OT
<u>Others (ppm)</u>							
Dacthal	ND	6800	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	1.0	ND	7.3	0.88	39.0	1.9	ND
Hexanedioic Acid Dioctyl							
Ester	ND	ND	ND	**	ND	**	ND
p-cresol	ND	ND	ND	ND	ND	ND	ND
phenyl ether	ND	ND	ND	ND	ND	ND	ND
biphenyl	ND	0.039	ND	ND	ND	ND	ND
Tinuvin 327	ND	ND	ND	ND	ND	ND	ND
Tinuvin 328	ND	ND	ND	ND	ND	ND	ND
Prometon	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>
	1.0	6800.039	7.3	0.88	39.0	1.9	

Notes:

ND = not detected.

MDL = minimum detection limit.

ppm = parts per million.

Analyses performed by Rhode Island Department of Health, Division of Laboratories.

\*\* = Appears to be present but its presence cannot be confirmed or quantified.

NA = not analyzed.

Table based on data reported by Versar, Inc. (1988).

TABLE 6-19  
FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN OFF-SITE SOIL SAMPLES COLLECTED ON 15 APRIL 1987  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	MDL	8	9	10	11	12	13	14	15	16	17
<u>Volatile Organics (ppm)</u>											
1,1,2,2-tetrachloroethane	0.5	0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND
<u>Polynuclear Aromatic Hydrocarbons (ppm)</u>											
naphthalene	0.1	ND	ND	ND	ND	0.19	ND	ND	ND	ND	ND
acenaphthylene	0.1	ND	0.2	ND	ND	0.38	0.26	ND	ND	ND	ND
acenaphthene	0.1	ND	ND	ND	ND	0.3	ND	ND	ND	ND	ND
fluorene	0.1	ND	0.14	ND	0.1	0.62	ND	ND	ND	ND	ND
phenanthrene	0.1	ND	1.5	0.36	0.84	6.6	0.78	0.36	0.1	ND	ND
anthracene	0.1	ND	0.14	ND	ND	0.7	0.14	ND	ND	ND	ND
fluoranthene	0.1	0.12	3.5	0.44	1.2	8.6	3.1	0.54	0.28	0.14	ND
pyrene	0.1	0.14	2.7	0.38	1.1	8.9	2.0	0.36	0.24	0.14	ND
benzo(a)anthracene	0.1	ND	1.6	0.26	0.4	4.2	1.7	0.26	0.16	ND	ND
chrysene	0.1	ND	0.72	0.14	0.34	3.5	1.1	ND	ND	ND	ND
benzo(b)fluoranthene	0.1	ND	2.7	ND	0.6	3.0	1.9	0.32	ND	ND	ND
benzo(k)fluoranthene	0.1	ND	2.1	ND	0.58	4.0	2.1	ND	ND	ND	ND
benzo(a)pyrene	0.1	ND	0.64	ND	0.62	11.0	5.3	ND	ND	ND	ND
ideno(1,2,3)pyrene	0.1	ND	1.7	ND	ND	5.7	ND	ND	ND	ND	ND
dibenzo(a,h)anthracene	0.1	ND	0.34	ND	ND	ND	ND	ND	ND	ND	ND
benzo(g,h,i)perylene	0.1	ND	1.2	ND	ND	ND	ND	ND	ND	ND	ND
		0.26	19.18	1.58	5.78	57.69	18.38	1.84	0.78	0.28	ND
<u>Others (ppm)</u>											
p-cresol	0.075	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
phenyl ether	0.075	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE 6-19 (continued)  
FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN OFF-SITE SOIL SAMPLES COLLECTED ON 15 APRIL 1987  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

	MDL	8	9	10	11	12	13	14	15	16	17
<u>Others (ppm) (continued)</u>											
biphenyl	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tinuvin 327	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tinuvin 328	0.5	ND	ND	ND	ND	ND	ND	0.84	ND	ND	ND
Prometon	0.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dacthal	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-tetramylphenol	0.025	ND	ND	0.04	ND	ND	ND	ND	ND	ND	ND
2,4-di-tertbutylphenol	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-phenyl-L-naphthylamine	0.075	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tinuvin P	0.01	ND	ND	0.02	ND	ND	0.01	ND	ND	ND	ND
diethyl phthalate	0.2	ND	ND	1.3	2.3	5.2	2.4	5.2	1.5	1.3	1.1
dibutyl phthalate	0.2	ND	0.4	ND	0.24	0.74	1.3	0.9	1.3	0.82	0.38
butylbenzyl phthalate	0.5	0.19	ND	ND	ND	8.4	2.6	ND	ND	ND	ND
bis(2-ethylhexyl)phthalate	0.5	19.0	11.0	57.0	1.8	4.5	45.0	5.8	200	2.90	0.84
DDT	0.5	ND	ND	ND	ND	ND	1.8	ND	ND	ND	ND
DDE	0.5	<u>ND</u>	<u>ND</u>	<u>2.2</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>	<u>ND</u>
		19.19	11.4	60.56	4.34	18.84	53.11	12.74	202.8	5.02	2.32

Notes:

ND = not detected.

MDL = minimum detection limit.

ppm = parts per million.

Analyses performed by the Rhode Island Department of Health, Division of Laboratories.

Table based on data reported by Versar, Inc. (1988).

TABLE 6-20

FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN SEDIMENT SAMPLES FROM THE PAWTUXET RIVER  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

	SD-1 (EPA)	SED-1 (CG)	SD-2 (EPA)	SED-2 (CG)	SD-3 (EPA)	SED-3 (CG)	SD-4 (EPA)	SED-4 (CG)
<b>Metals (ppm)</b>								
antimony	44		32		26		<45	
arsenic	6.5		6.6		2.8		9.3	
barium	182	NA	133	NA	18	NA	222	NA
beryllium	1.5	2.0	1.2	1.3	<0.58	<0.23	1.7	<2.5
cadmium	16	3.9	3	ND	<1.3	ND	5.9	ND
copper	NA	211	NA	203	NA	15	NA	516
chromium	79	61	310	226	14	210	1080	827
iron	18600	NA	19200	NA	9380	NA	21100	NA
lead	237	<35	188	<26	17	<3.8	369	<47
magnesium	1880	NA	2820	NA	1100	NA	3610	NA
manganese	560	NA	302	NA	100	NA	266	NA
mercury	10	ND	6.3	0.62	<11	ND	23	0.32
nickel	33	3.6	<15	ND	<7.8	ND	<22	ND
selenium	NA		NA		NA		NA	
silver	<5.1	5.2	<4.0	<1.0	<2.1	ND	<5.9	<2.2
thallium	NA		NA		NA		NA	
vanadium	29	NA	33	NA	7.8	NA	43	NA
zinc	389	<274	528	<373	52	<18	2280	<1770
<b>Volatile Organics (ppm)</b>								
<b>BTEX COMPOUNDS:</b>								
toluene	0.03	0.033	ND	0.13	0.001J	ND	ND	0.23
<b>CHLORINATED VOLATILES:</b>								
tetrachloroethylene	ND		ND		ND		1.7	
chlorobenzene	ND	ND	ND	0.13	ND	ND	ND	ND
methylene chloride	<u>0.067B</u>	<u>0.009JB</u>	<u>0.56JB</u>	<u>ND</u>	<u>0.004JB</u>	<u>ND</u>	<u>1.2B</u>	<u>0.065JB</u>
	0.067B	0.009JB	0.56JB	0.13	0.004JB	ND	2.98	0.065JB
<b>OTHER COMPOUNDS:</b>								
2-butanone	ND	ND	2.4B	ND	ND	ND	4.0B	0.74J
acetone	<u>0.208</u>	<u>0.180J</u>	<u>0.83JB</u>	<u>1.8J</u>	<u>0.005J</u>	<u>0.089J</u>	<u>2.0JB</u>	<u>4.7J</u>
	0.208	0.180J	3.23JB	1.8J	0.005J	0.089J	6.0JB	5.44J

TABLE 6-20 (continued)

FACILITY ASSESSMENT SUMMARY OF CONSTITUENTS DETECTED IN SEDIMENT SAMPLES FROM THE PAWTUXET RIVER  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

	SD-1 (EPA)	SED-1 (CG)	SD-2 (EPA)	SED-2 (CG)	SD-3 (EPA)	SED-3 (CG)	SD-4 (EPA)	SED-4 (CG)
<u>Semi-Volatile Organics (ppm)</u>								
POLYCYCLIC AROMATIC HYDROCARBONS:								
fluoranthene	1.4	1.9	ND	2.2	ND	0.76	6.5	17.0
pyrene	1.1	1.0B	ND	1.4B	ND	0.46B	6.5	5.9JB
chrysene	0.79J	0.78	ND	ND	ND	0.38J	3.7J	5.1
benzo(b)fluoranthene	1.0	1.7	ND	2.2	ND	ND	3.4J	11.0
benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	3.1	ND
benzo(a)pyrene	0.52J	1.0	ND	1.5	ND	0.42	2.7J	4.6
benzo(g,h,i)perylene	0.31J	0.54J	ND	ND	ND	ND	1.8J	ND
phenanthrene	0.7J	0.78	ND	1.0	ND	0.42	4.3	7.7
indeno(1,2,3-cd)pyrene	ND	0.7	ND	0.76J	ND	ND	1.5J	2.9
benzo(a)anthracene	0.52J	ND	ND	0.76	ND	0.3J	ND	ND
2-methylnaphthalene	ND	ND	ND	0.14J	ND	ND	ND	0.32J
acenaphthylene	ND	0.16J	ND	ND	ND	0.84J	ND	2.2
fluorene	ND	ND	ND	0.21J	ND	ND	ND	ND
anthracene	ND	0.16J	ND	0.21J	ND	0.084J	ND	ND
naphthalene	ND	ND	ND	ND	ND	ND	ND	0.43J
	6.34J	8.72JB	ND	10.38JB	ND	3.664JB	33.5J	57.15J
PHthalate ESTERS:								
butylbenzylphthalate	0.13J	ND	ND	ND	ND	ND	ND	ND
bis-2-ethylhexylphthalate	10.0	8.7B	ND	5.8B	19.0	3.4B	2.0J	2.8B
di-n-octylphthalate	0.49J	ND	ND	ND	6.4	1.4J	ND	ND
di-n-butylphthalate	ND	ND	ND	ND	ND	0.042J	ND	ND
	10.62J	8.7B	ND	5.8B	25.4	4.842JB	2.0J	2.8B
<u>Pesticides/PCBs (ppm)</u>								
dieldren	ND	ND	ND	0.89	ND	ND	ND	ND
<u>Dioxin (TCDD)/Furan (TCDF) (ppm)</u>								
	ND	ND	NA	NA	NA	NA	ND	ND

TABLE 6-20 (continued)

PRELIMINARY INVESTIGATION SUMMARY OF CONSTITUENTS DETECTED IN SEDIMENT SAMPLES FROM THE PAWTUXET RIVER  
CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND

---

NOTES:

J = CONCENTRATION IS AN ESTIMATED VALUE LESS THAN THE METHOD DETECTION LIMIT.

ND = NOT DETECTED.

NA = NOT ANALYZED.

< = LESS THAN THE NUMBER SHOWN; INDICATES THE DETECTION LIMIT.

BLANK SPACE INDICATES UNKNOWN WHETHER THE PARAMETER WAS TESTED AND NOT DETECTED, OR NOT TESTED.

TABLE BASED ON DATA PRESENTED IN THE RFA (VERSAR, INC., 1988).

ppm = PARTS PER MILLION.

CG = CIBA-GEIGY SAMPLE.

EPA = UNITED STATES ENVIRONMENTAL PROTECTION AGENCY SAMPLE COLLECTED BY VERSAR, INC.

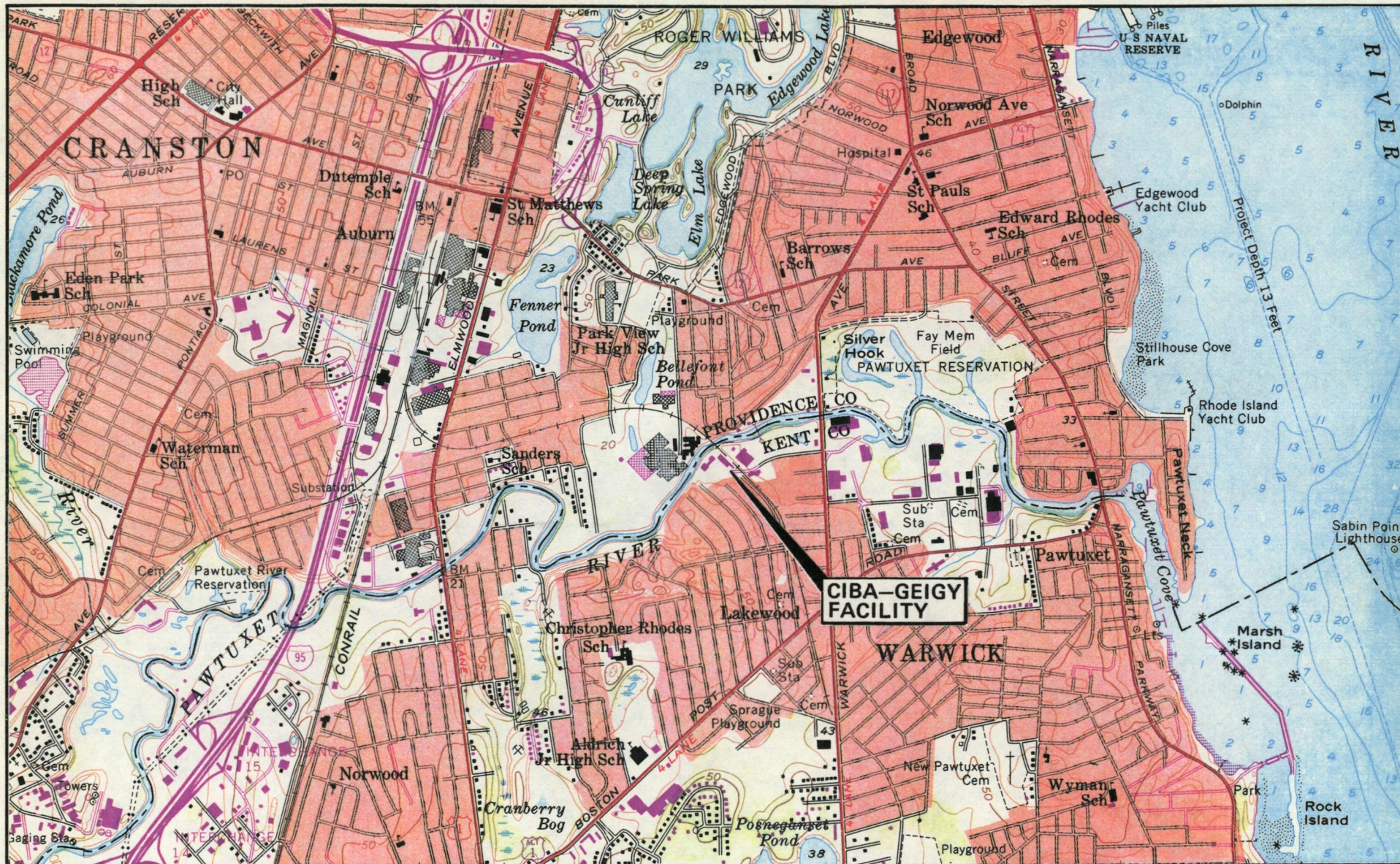
SPLIT SAMPLES WERE OBTAINED DURING THE SEDIMENT SAMPLING. THE SAMPLES AND SPLITS ARE AS FOLLOWS: SD-1 AND  
SED-1, SD-2 AND SED-2, SD-3 AND SED-3, SD-4 AND SED-4.

SAMPLES WERE COLLECTED ON 12 JUNE 1987



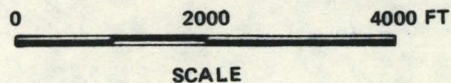
## **Figures**





**BASE MAP SOURCE:**

USGS 7.5 MINUTE PROVIDENCE,  
RI QUADRANGLE, PHOTOREVISED  
1970, 1975.



**FACILITY LOCATION MAP  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND**

**WOODWARD-CLYDE CONSULTANTS**

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

DR. BY: RTL	SCALE: AS SHOWN	PROJ. NO.: 87X4660
CK'D. BY: TGC	DATE: 5 FEB 1988	FIG. NO.: 2-1



N 251000

N 250000

N 249000

N 248000

N 247000

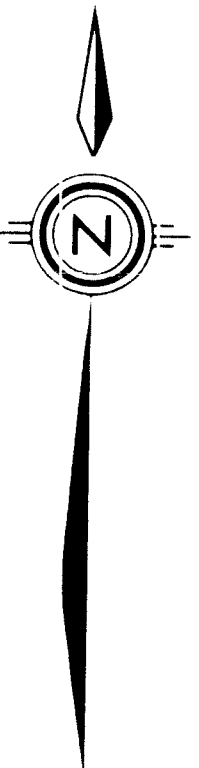
E 523000

E 524000

E 525000

E 526000

0 200 400 FT  
SCALE



BELLEFONT POND

ATLANTIC TUBING  
AND RUBBER COMPANY

PAWQUET  
RIVER

VINE AVENUE

WARWICK AVENUE

LEGEND

- CIBA-GEIGY CORPORATION PROPERTY (LEGAL BOUNDARIES)
- FORMER ATLANTIC TUBING AND RUBBER COMPANY PROPERTY INCLUDED WITHIN CIBA-GEIGY LEGAL BOUNDARIES
- RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- PUBLIC SCHOOL AND PLAY AREA
- UNDEVELOPED

NOTE: GRID IS BASED ON RHODE ISLAND STATE PLANE COORDINATE SYSTEM

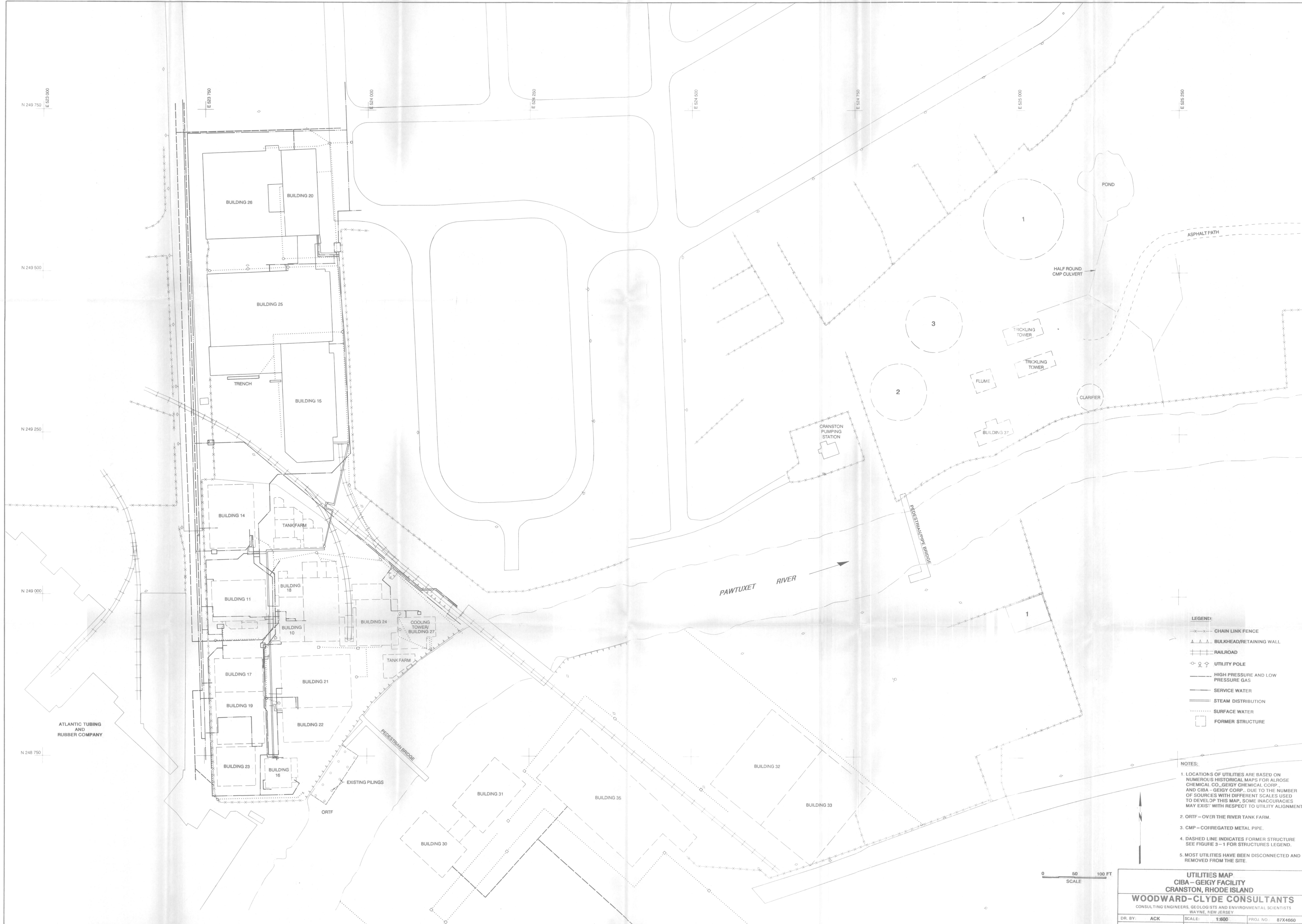
SURROUNDING LAND USE MAP  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

WOODWARD-CLYDE CONSULTANTS  
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

DATE	12/1/88	SCALE	1"=2400'	PROJ. NO.	87X4660
FIG. NO.	2-2	DATE	22 JUN 1989	PROJ. NO.	87X4660

BASE MAP SOURCE: GEOD. CORP. OF NEWFOUNDLAND, NEW JERSEY. MAPPED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS. DATE FLOWN: 2 APRIL 1989





- LEGEND:
- CHAIN LINK FENCE
  - BULKHEAD/RETAINING WALL
  - RAILROAD
  - UTILITY POLE
  - HIGH PRESSURE AND LOW PRESSURE GAS
  - SERVICE WATER
  - STEAM DISTRIBUTION
  - SURFACE WATER
  - FORMER STRUCTURE

- NOTES:
1. LOCATIONS OF UTILITIES ARE BASED ON NUMEROUS HISTORICAL MAPS FOR ALROSE CHEMICAL CO., GEIGY CHEMICAL CORP., AND CIBA - GEIGY CORP. DUE TO THE NUMBER OF SOURCES WITH DIFFERENT SCALES USED TO DEVELOP THIS MAP, SOME INACCURACIES MAY EXIST WITH RESPECT TO UTILITY ALIGNMENT.
  2. ORTF - OVER THE RIVER TANK FARM.
  3. CMP - CORRUGATED METAL PIPE.
  4. DASHED LINE INDICATES FORMER STRUCTURE SEE FIGURE 3 - 1 FOR STRUCTURES LEGEND.
  5. MOST UTILITIES HAVE BEEN DISCONNECTED AND REMOVED FROM THE SITE.

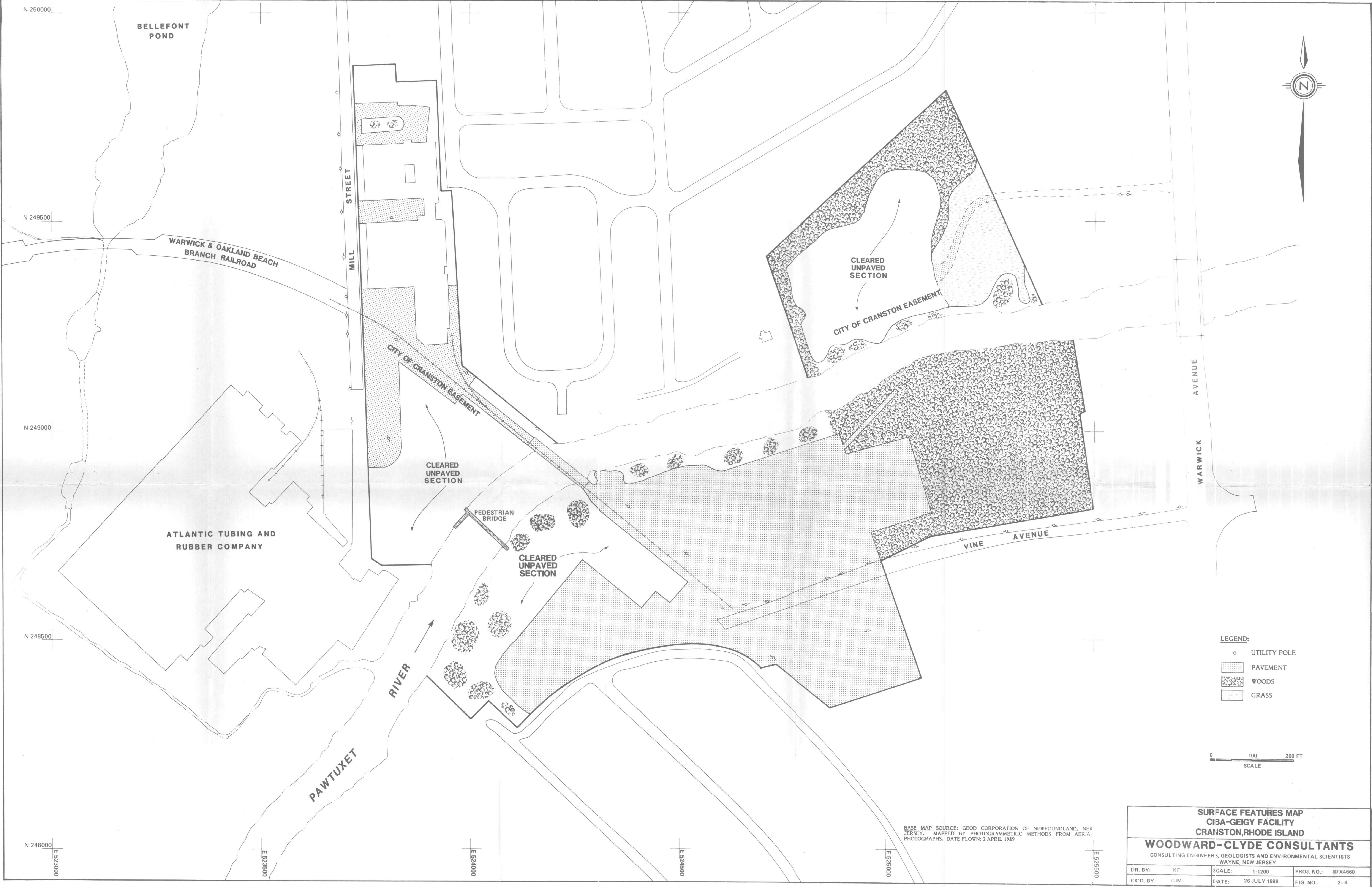
UTILITIES MAP  
CIBA - GEIGY FACILITY  
CRANSTON, RHODE ISLAND  
WOODWARD-CLYDE CONSULTANTS  
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

DR. BY: ACK	SCALE: 1"=600'	PROJ. NO: 87X4660
CK'D BY: CWT	DATE: 19 FEB 1990	FIG. NO.: 2-3A







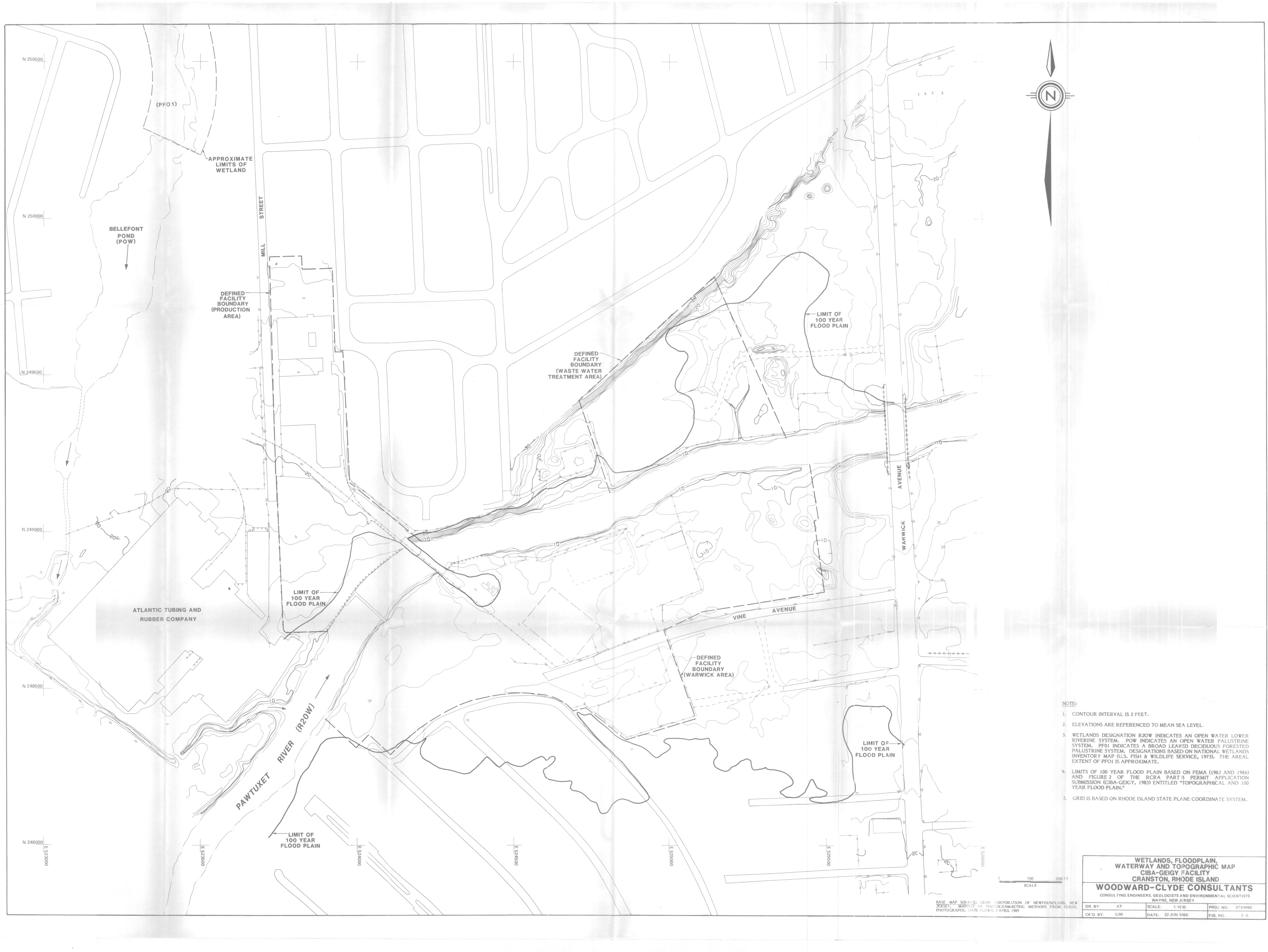


BASE MAP SOURCE: GEOD CORPORATION OF NEWFOUNDLAND, NEW JERSEY. MAPPED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS. DATE FLOWN: 2 APRIL 1989

**SURFACE FEATURES MAP**  
**CIBA-GEIGY FACILITY**  
**CRANSTON, RHODE ISLAND**  
**WOODWARD-CLYDE CONSULTANTS**  
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

DR. BY: KF	SCALE: 1:1200	PROJ. NO.: 87X4660
CK'D. BY: CJM	DATE: 26 JULY 1989	FIG. NO.: 2-4





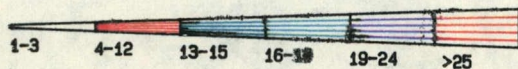
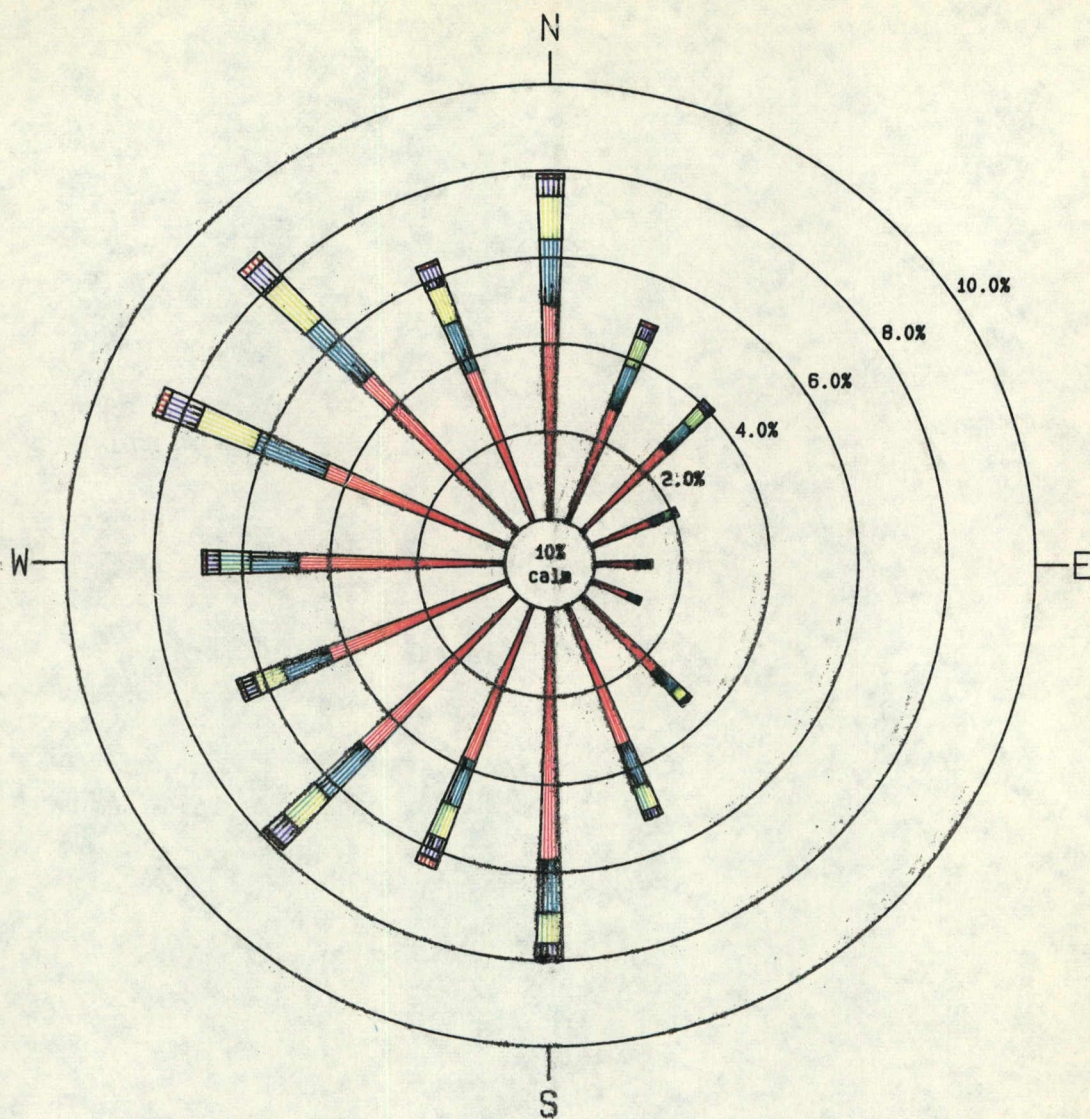
**NOTE:**

1. CONTOUR INTERVAL IS 2 FEET.
2. ELEVATIONS ARE REFERENCED TO MEAN SEA LEVEL.
3. WETLANDS DESIGNATION R20W INDICATES AN OPEN WATER LOWER RIVERINE SYSTEM. POW INDICATES AN OPEN WATER PALUSTRINE SYSTEM. PFO1 INDICATES A BROAD LEAVED DECIDUOUS FORESTED PALUSTRINE SYSTEM. DESIGNATIONS BASED ON NATIONAL WETLANDS INVENTORY MAP (U.S. FISH & WILDLIFE SERVICE, 1975). THE AREAL EXTENT OF PFO1 IS APPROXIMATE.
4. LIMITS OF 100 YEAR FLOOD PLAIN BASED ON FEMA (1982 AND 1984) AND FIGURE 2 OF THE RCRA PART 3 PERMIT APPLICATION SUBMISSION (CIBA-GEIGY, 1985) ENTITLED "TOPOGRAPHICAL AND 100 YEAR FLOOD PLAIN."
5. GRID IS BASED ON RHODE ISLAND STATE PLANE COORDINATE SYSTEM.

<b>WETLANDS, FLOODPLAIN, WATERWAY AND TOPOGRAPHIC MAP CIBA-GEIGY FACILITY CRANSTON, RHODE ISLAND</b>			
<b>WOODWARD-CLYDE CONSULTANTS</b>			
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS WAYNE, NEW JERSEY			
DR. BY: KF	SCALE: 1:1250	PROJ. NO.: 87X6660	
CK'D. BY: GJM	DATE: 22 JUN 1989	FIG. NO.: 2-5	

BASE MAP SOURCE: GEOD. CORPORATION OF NEWFOUNDLAND, NEW JERSEY. MAPD BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS. DATE FLOWN: 2 APRIL 1989





Wind Speed Classes  
( mph )

**WINDROSE FOR T. F. GREEN AIRPORT  
WARWICK, RHODE ISLAND  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND**

**WOODWARD - CLYDE CONSULTANTS**

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

DR. BY: BAS

SCALE: AS SHOWN

PROJ. NO.: 87X4660

CK'D BY: CT

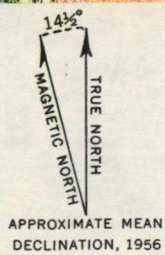
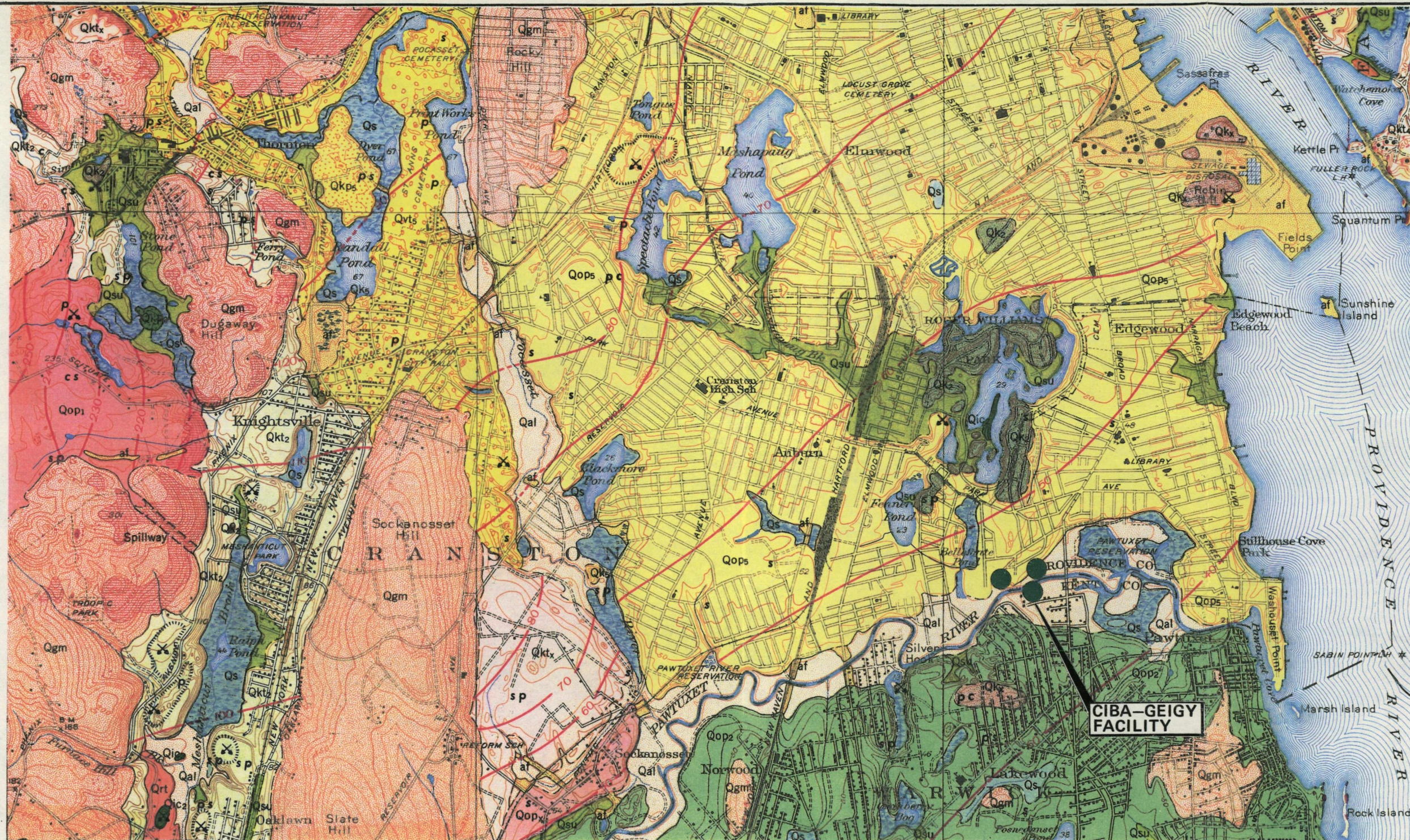
DATE: 22 FEB 1990

FIG. NO.: 2-6

**SOURCE:**

NATIONAL OCEANIC AND ATMOSPHERIC  
ADMINISTRATION, DATE 1981.

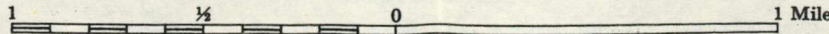




GEOLOGIC MAP  
OF THE  
**PROVIDENCE QUADRANGLE, RHODE ISLAND**  
SURFICIAL GEOLOGY

By  
**J. Hiram Smith**

Scale 1:31 680



Contour interval 10 feet  
Datum is mean sea level

1956

REGIONAL SURFICIAL GEOLOGY MAP		
CIBA - GEIGY FACILITY		
CRANSTON, RHODE ISLAND		
<b>WOODWARD - CLYDE CONSULTANTS</b>		
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS		
WAYNE, NEW JERSEY		
DR. BY: KF	SCALE: AS SHOWN	PROJ. NO.: 87X4660
CK'D. BY: CJM	DATE: 15 FEB 1990	FIG. NO.: 2-7A



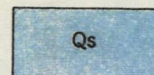
Recent

Pleistocene

QUATERNARY

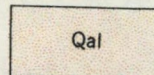
PENNSYLVANIAN AND  
PRE-PENNSYLVANIAN

## EXPLANATION



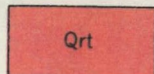
## Swamp deposits

Sand and Silt mixed with varying amounts of partly decomposed organic material; commonly with a thin surface layer of peaty material.



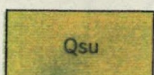
## Flood-plain deposits

Chiefly medium to fine sand; in places interbedded gravel deposited by recent streams during flood stage.



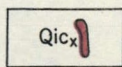
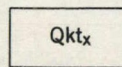
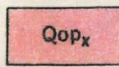
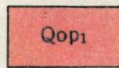
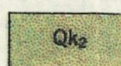
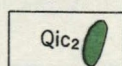
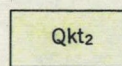
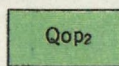
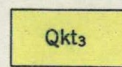
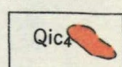
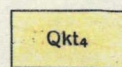
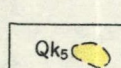
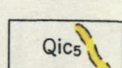
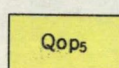
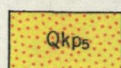
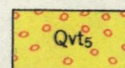
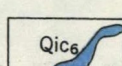
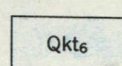
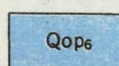
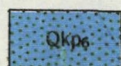
## River terraces

Medium to coarse sand and, in places, thin beds of gravel deposited as early alluvium. Terraces along the Seekonk River probably are erosional.



## Sand and gravel undifferentiated

Chiefly sand and, in places, small gravel lenses; in most places represent thin deposits formed in kettle holes; in other places represent small, local deposits formed during melting of ice block, or in temporary channels, which existed during the late stage of deglaciation.



**Valley train**  
Stratified sand and gravel deposited by glacial streams in the valley bottoms.

**Kame plains**  
Flat-topped deposits of sand and gravel with ice-contact slopes on all sides.

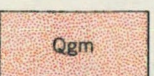
**Outwash plains**  
Sorted sand and local deposits of coarse gravel.

**Kame terraces**  
Sand and gravel deposited by meltwater streams between ice in the valley and the valley wall.

**Ice channel deposits**  
Ridges of sand and gravel; includes eskers and crevasse fillings.

**Kames**  
Irregularly shaped mounds of sand and gravel.

Deposits graded to a local, temporary base level are shown by a single color. Order of deposition of each sequence shown by number subscripts of letter symbols; the letter "x" sub script indicates that the chronological order of deposition for that feature is not known.



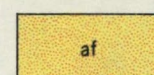
## Ground moraine

Relatively thin layer of till with lenses of sorted material incorporated within the till; rest chiefly on bedrock.



## Bedrock outcrops

Solid color represents individual outcrops; ruled area represents group of closely spaced outcrops.



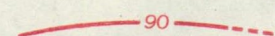
## Artificial fill

Areas altered by artificial fill or excavation.

## Contact

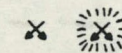
Solid line represents accurately located boundary; dashed line indicates gradational or approximate boundary.

Direction of ice movement as shown by grooves, striae, and friction cracks  
Point of observation is point of arrow.



## Interpreted contour

Drawn on restored integrated surface, dashed across those areas that are no longer part of the sequence.



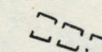
## Sand and gravel pit

Larger pits are hachured to show approximate boundaries.

s p c

## Composition of deposits

Letter symbols indicate the composition of the deposit at that point; symbols arranged in order of relative abundance with most abundant material first: s, sand; p, pebble gravel; and c, cobble gravel.



## Outflow channel

Outlet through which glacial meltwater stream flowed.

LEGEND FOR FIGURE 2-7  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

WOODWARD - CLYDE CONSULTANTS

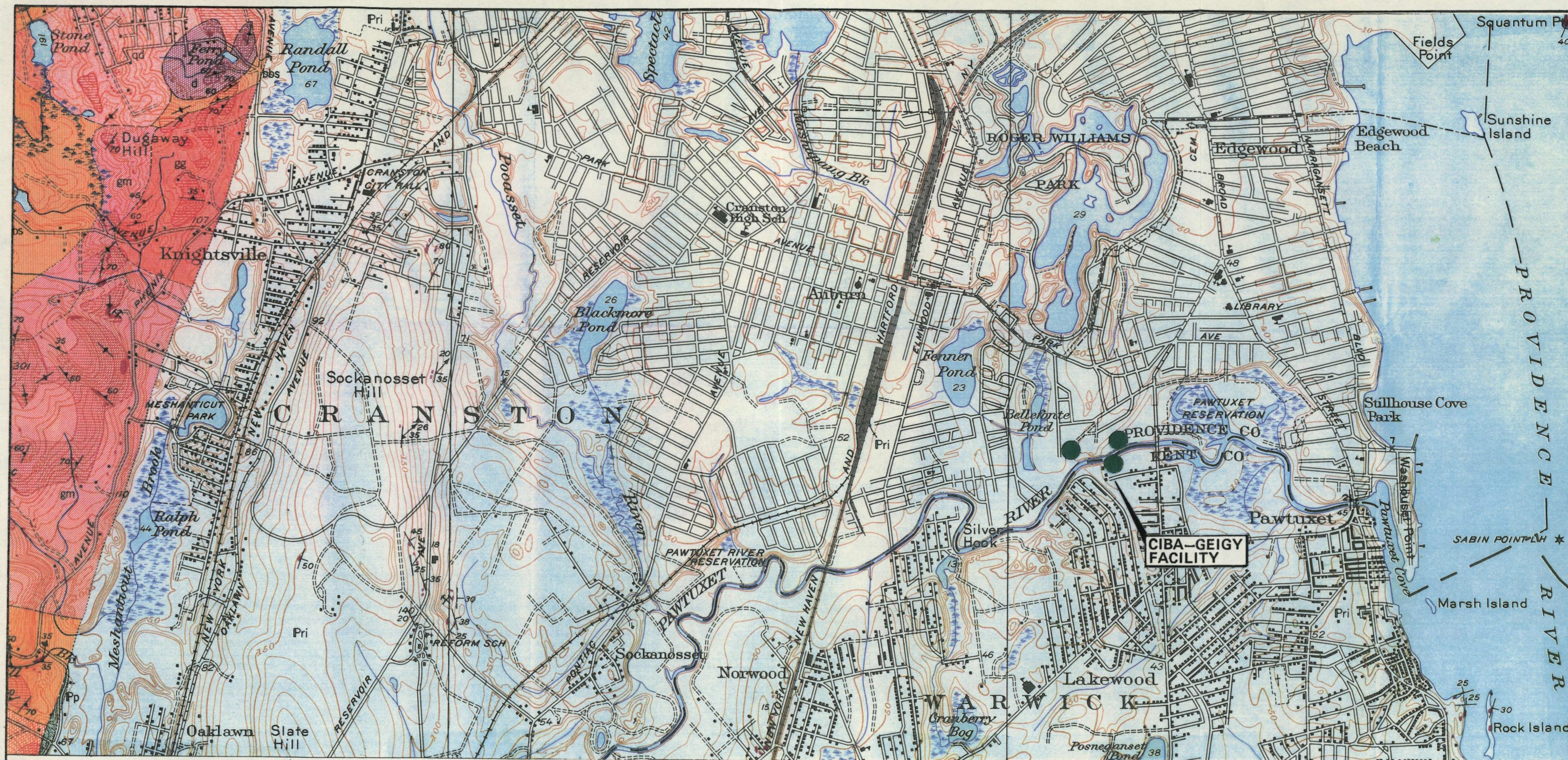
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

WAYNE, NEW JERSEY

DR. BY: KF SCALE: NONE PROJ. NO.: 87X4660

CK'D. BY: CJM DATE: 15 FEB 1990 FIG. NO.: 2-7B

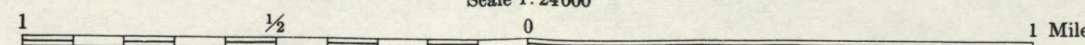




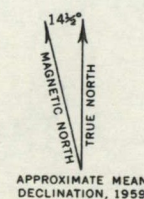
**GEOLOGIC MAP  
OF THE  
PROVIDENCE QUADRANGLE, RHODE ISLAND  
BEDROCK GEOLOGY**

By  
Alonzo W. Quinn  
1959

Scale 1: 24000



Contour interval 10 feet  
Datum is mean sea level

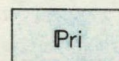


REGIONAL BEDROCK GEOLOGY MAP		
CIBA - GEIGY FACILITY		
CRANSTON, RHODE ISLAND		
WOODWARD - CLYDE CONSULTANTS		
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS		
WAYNE, NEW JERSEY		
DR. BY: KF	SCALE: AS SHOWN	PROJ. NO.: 87X4660
CK'D BY: CJM	DATE: 15 FEB 1990	FIG. NO.: 2-8A



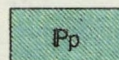
# EXPLANATION

Sedimentary rocks of Narragansett basin



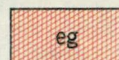
## Rhode Island formation

Greenish, gray, dark-gray, to black graywacke, conglomerate, sandstone, shale, and meta-anthracite, as well as a few beds of red sandstone and shale at the northeast corner of the quadrangle; irregular bedding and crossbedding common; essentially unmetamorphosed in the north and changed to slate, phyllite, and schist in the south. May include Pondville conglomerate in covered areas



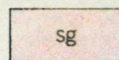
## Pondville conglomerate

Gray, coarse-grained conglomerate, containing pebbles and cobbles of quartzite, schist, granite, and granite gneiss in a sandy or shaly matrix; beds irregular and discontinuous; pebbles elongate in southern half of quadrangle



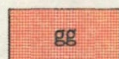
## Esmond granite

Light-gray to light-pink, medium-grained massive



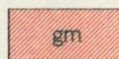
## Scituate granite gneiss

Light-gray to pink, medium- to coarse-grained; characterized by splotchy arrangement of biotite



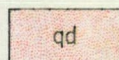
## Grant Mills granodiorite

Gray to greenish-gray, porphyritic, massive to foliated and streaky



## Granite gneiss

Light-gray to dark-gray, fine- to medium-grained; in places containing numerous schist relicts in various stages of replacement



## Quartz diorite

Dull-gray to dark-gray, medium-grained and porphyritic, generally massive, but foliated where porphyritic; fine-grained and more foliated just east of Wenscott Reservoir

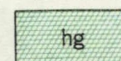


## Diorite

Gray to dark-gray, medium- to coarse-grained, massive to schistose

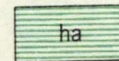
PENNSYLVANIAN

DEVONIAN (?) OR OLDER



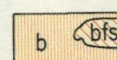
## Hunting Hill greenstone

Dark-green, fine-grained, massive to schistose; in part with clastic texture; veins and knots of epidote common



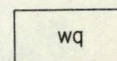
## Metamorphosed porphyritic andesite

Green, fine- to medium-grained, somewhat schistose; small patches of black biotite, knots and veinlets of epidote common; locally has a few pebbles; exposed only near north margin of quadrangle



## Sneech Pond schist

Chiefly gray to greenish-gray, fine-grained, schistose, interbedded schist, greenstone, quartzite, and marble, b; gray to light gray, medium- to coarse-grained, streaky feldspathic schist, with interbeds of quartzite; exposed northeast of Centerdale, bfs



## Westboro quartzite

Bluish-gray to gray, medium-grained, massive to thin-bedded quartzite; with interbeds of greenish quartz-mica schist



## Mussey Brook schist

Chiefly green to greenish-gray, fine-grained, thin-bedded chlorite-quartz schist, but includes thin beds of hornblende schist, biotite schist, quartzite, marble, greenstone, steatite, and serpentine, bcs; dark-gray to green, fine- to medium-grained amphibolite, schistose along margins, massive elsewhere, ba; gray to light-gray, medium- to fine-grained, thin-bedded to massive quartzite; includes beds of quartz-mica schist, bq; green to gray, fine-grained biotite-quartz schist, interbedded with quartz-mica schist, chlorite schist, amphibole schist, marble, and quartzite, bbs



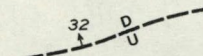
Bedrock outcrops and areas of closely spaced bedrock outcrops

Blackstone series

PRECAMBRIAN (?)

## Contact

Long dashes where approximately located; short dashes where indefinite; dotted where concealed



Fault, approximately located, showing strike and dip of fault plane

u, upthrown side; d, downthrown side

25

Strike and dip of bedding

90

Strike of vertical bedding

60

Strike and dip of foliation

34

Strike of vertical foliation

60

Direction and plunge of lineation

60

Direction and plunge of fold axes

90/45

Strike of vertical bedding and strike and dip of foliation

45

Strike and dip of parallel bedding and foliation

31/40

Strike and dip of parallel bedding and foliation; bearing and plunge of lineation

90

Strike of vertical bedding and foliation

25

Strike of vertical foliation; bearing and plunge of lineation

60

Strike and dip of foliation; bearing and plunge of fold axes

26

Strike and dip of bedding; bearing and plunge of fold axes

50

Structure symbols dashed where exposure is not now accessible

3

Quarry or mine

m x

Small quarry, mine or prospect

Letter symbol indicates type of deposit; steatite, s; marble, m

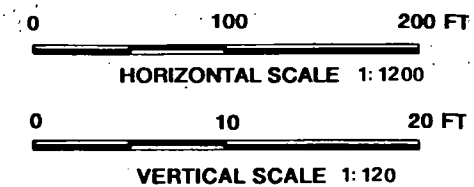
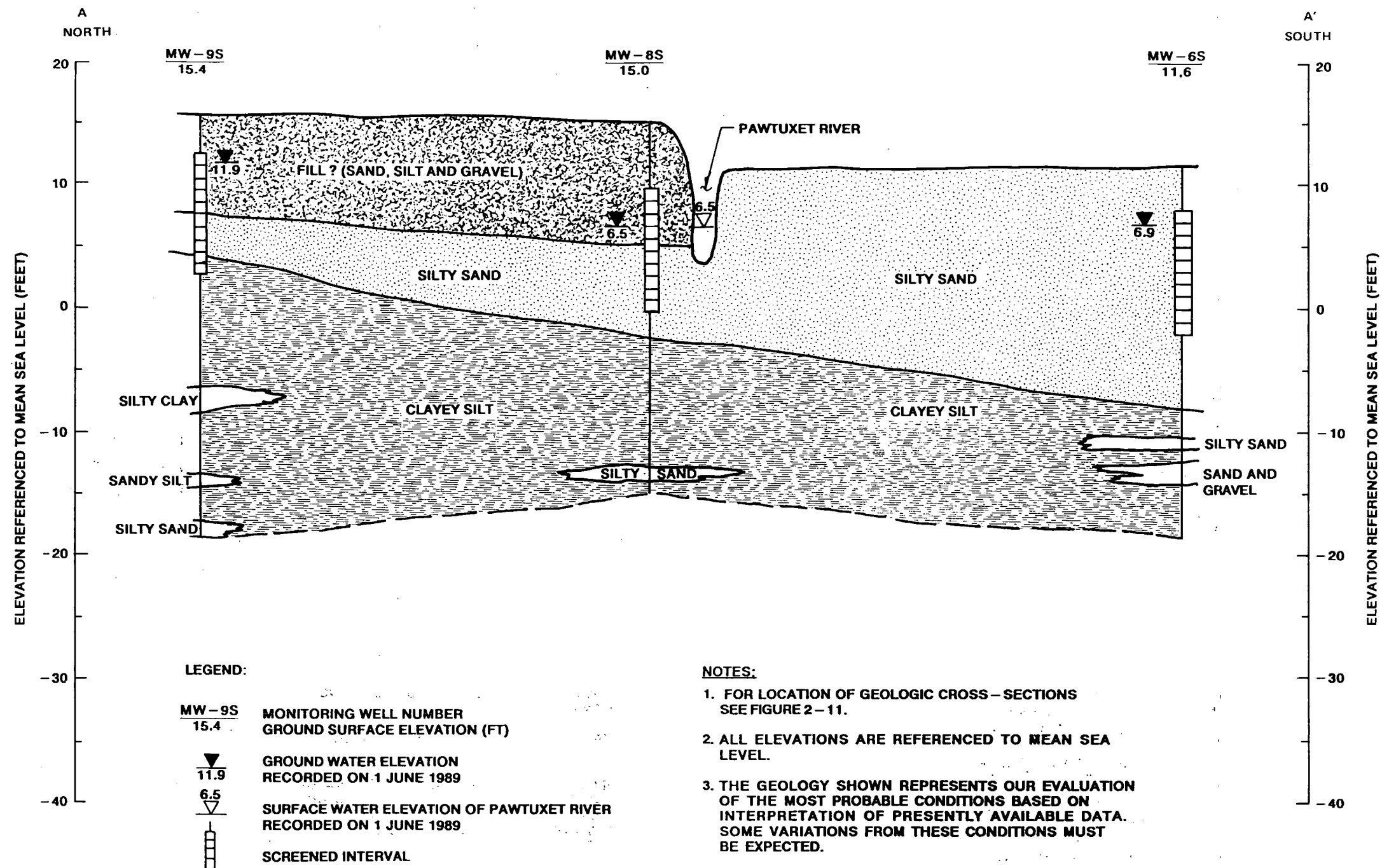
## LEGEND FOR FIGURE 2-8 CIBA-GEIGY FACILITY CRANSTON, RHODE ISLAND

### WOODWARD - CLYDE CONSULTANTS

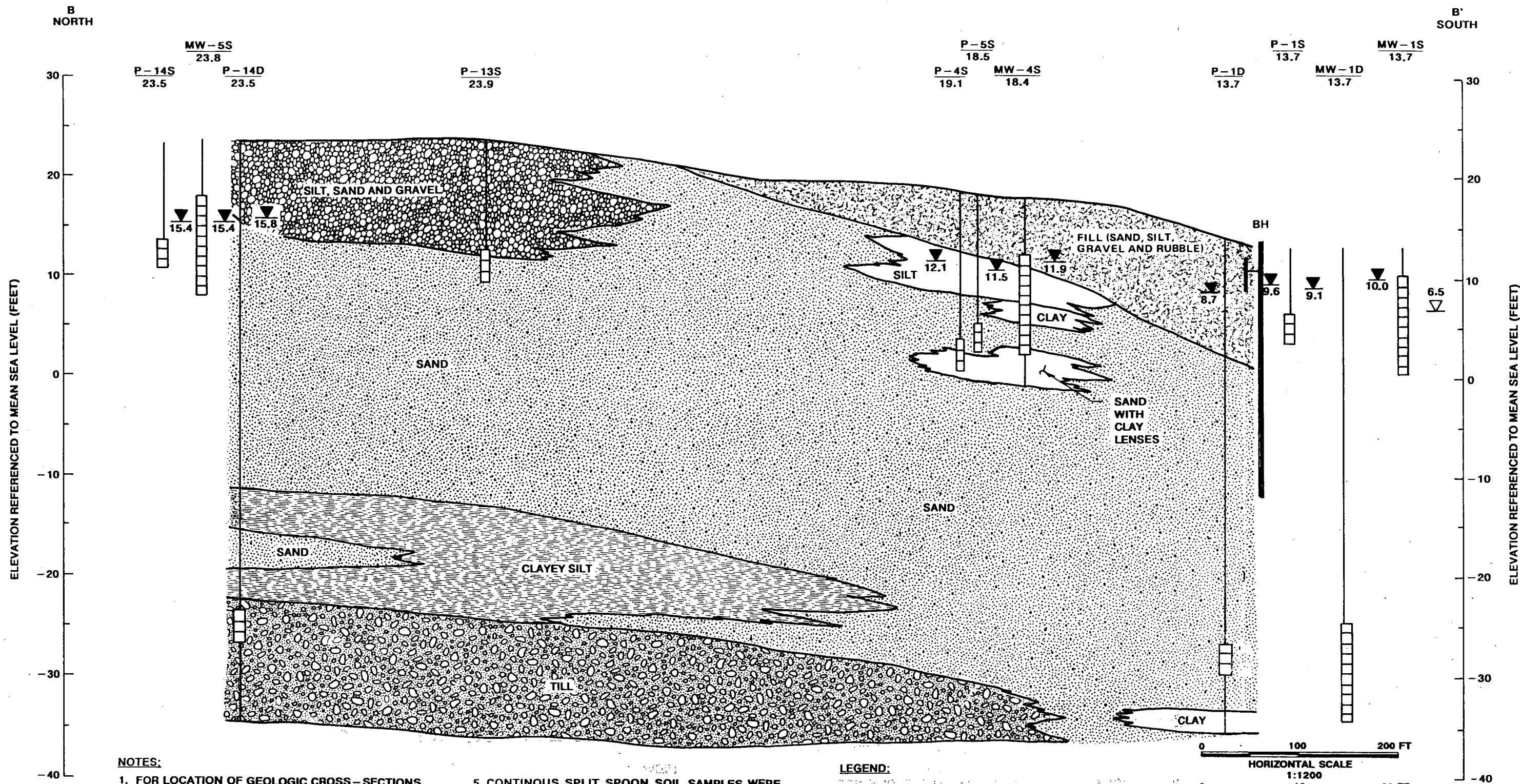
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

DR. BY: KF	SCALE: NONE	PROJ. NO.: 87X4660
CK'D. BY: CJM	DATE: 15 FEB 1990	FIG. NO.: 2-8B





GEOLOGIC CROSS SECTION A-A'		
CIBA - GEIGY FACILITY		
CRANSTON, RHODE ISLAND		
<b>WOODWARD - CLYDE CONSULTANTS</b>		
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS		
WAYNE, NEW JERSEY		
DR. BY: KF	SCALE: AS SHOWN	PROJ. NO.: 87X4660
CK'D. BY: CJM	DATE: 28 JUNE 1989	FIG. NO.: 2-9



#### NOTES:

- FOR LOCATION OF GEOLOGIC CROSS-SECTIONS SEE FIGURE 2-11.
- ALL ELEVATIONS ARE REFERENCED TO MEAN SEA LEVEL.
- THE GEOLOGY SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED ON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.
- P-13S PROJECTED 80 FEET WEST.  
P-4S PROJECTED 90 FEET WEST.  
P-5S PROJECTED 60 FEET EAST.

5. CONTINUOUS SPLIT SPOON SOIL SAMPLES WERE COLLECTED FROM BORING P-1D. STRATIGRAPHIC DATA WERE USED TO CONSTRUCT THE CROSS-SECTION. STRATIGRAPHIC DATA WERE NOT OBTAINED FROM BORING MW-15, MW-1D, AND P-1S. DUE TO GRAPHICAL LIMITATIONS, THOSE BORINGS ARE NOT INCLUDED WITHIN THE CROSS-SECTION. THEY ARE PROJECTED SOUTH OF THEIR ACTUAL LOCATIONS.

#### LEGEND:

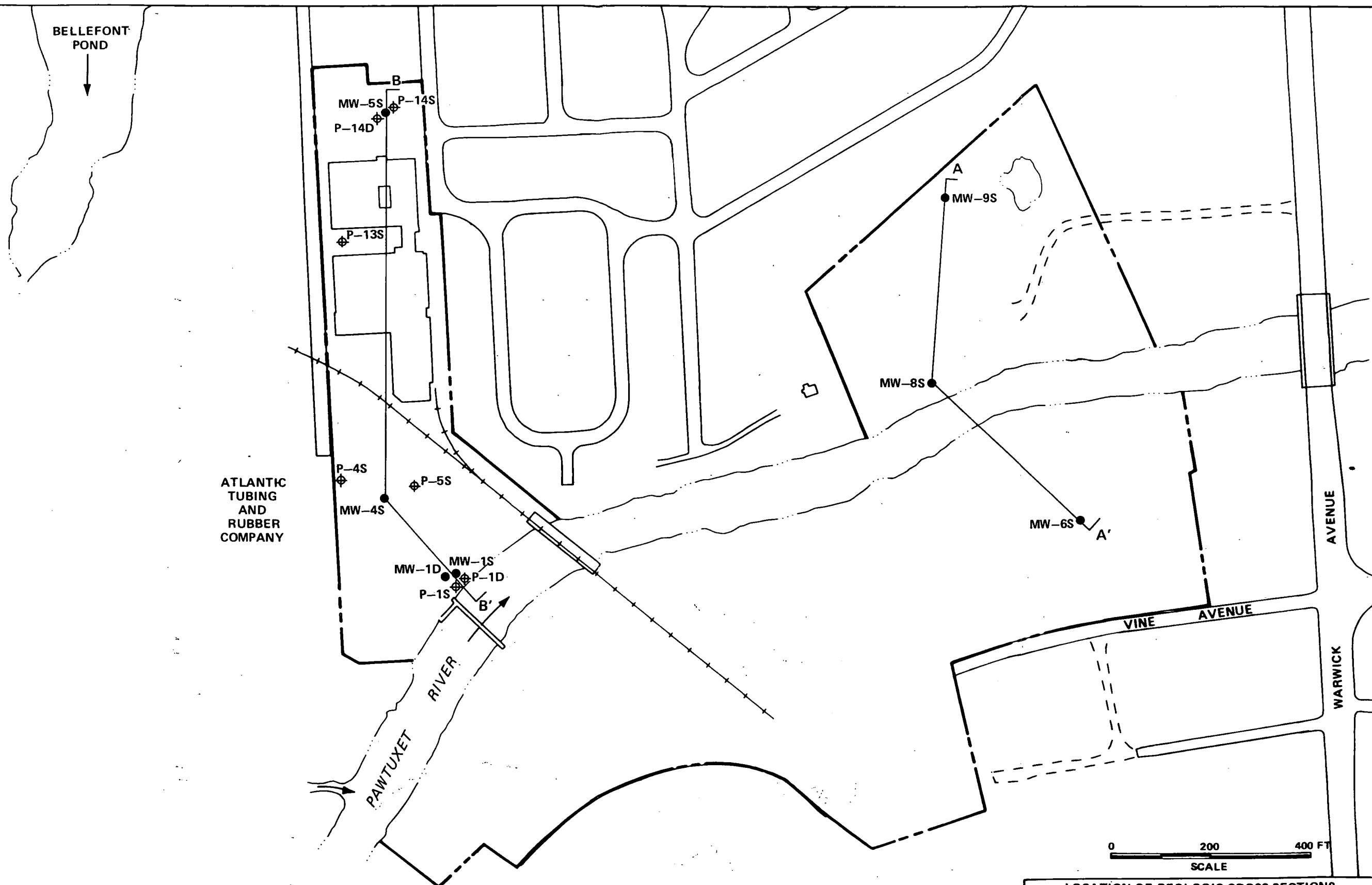
- |       |   |
|-------|---|
| MW-5S | MONITORING WELL NUMBER                    |
| 23.8  | GROUND SURFACE ELEVATION (FT)             |
| 15.4  | GROUND WATER ELEVATION                    |
| 6.5   | RECORDED ON 1 JUNE 1989                   |
| 6.5   | SURFACE WATER ELEVATION OF PAWTUXET RIVER |
|       | RECORDED ON 1 JUNE 1989                   |
|       | SCREENED INTERVAL                         |
| BH    | BULKHEAD                                  |

HORIZONTAL SCALE  
1:1200  
0 100 200 FT  
VERTICAL SCALE  
1:120  
0 10 20 30 40 FT

#### GEOLOGIC CROSS SECTION B-B' CIBA-GEIGY FACILITY CRANSTON, RHODE ISLAND

**WOODWARD - CLYDE CONSULTANTS**  
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

DR. BY: KF	SCALE: AS SHOWN	PROJ. NO.: 87X4660
CK'D. BY: CJM	DATE: 28 JUNE 1989	FIG. NO.: 2-10



**LEGEND:**

- MW-5S ● EXISTING MONITORING WELL  
P-14D ⊕ EXISTING PIEZOMETER

B — B' TREND OF GEOLOGIC CROSS-SECTION

NOTE: MONITORING WELL AND PIEZOMETER LOCATIONS BASED ON SURVEY BY WATERMAN ENGINEERING COMPANY OF EAST PROVIDENCE, RHODE ISLAND

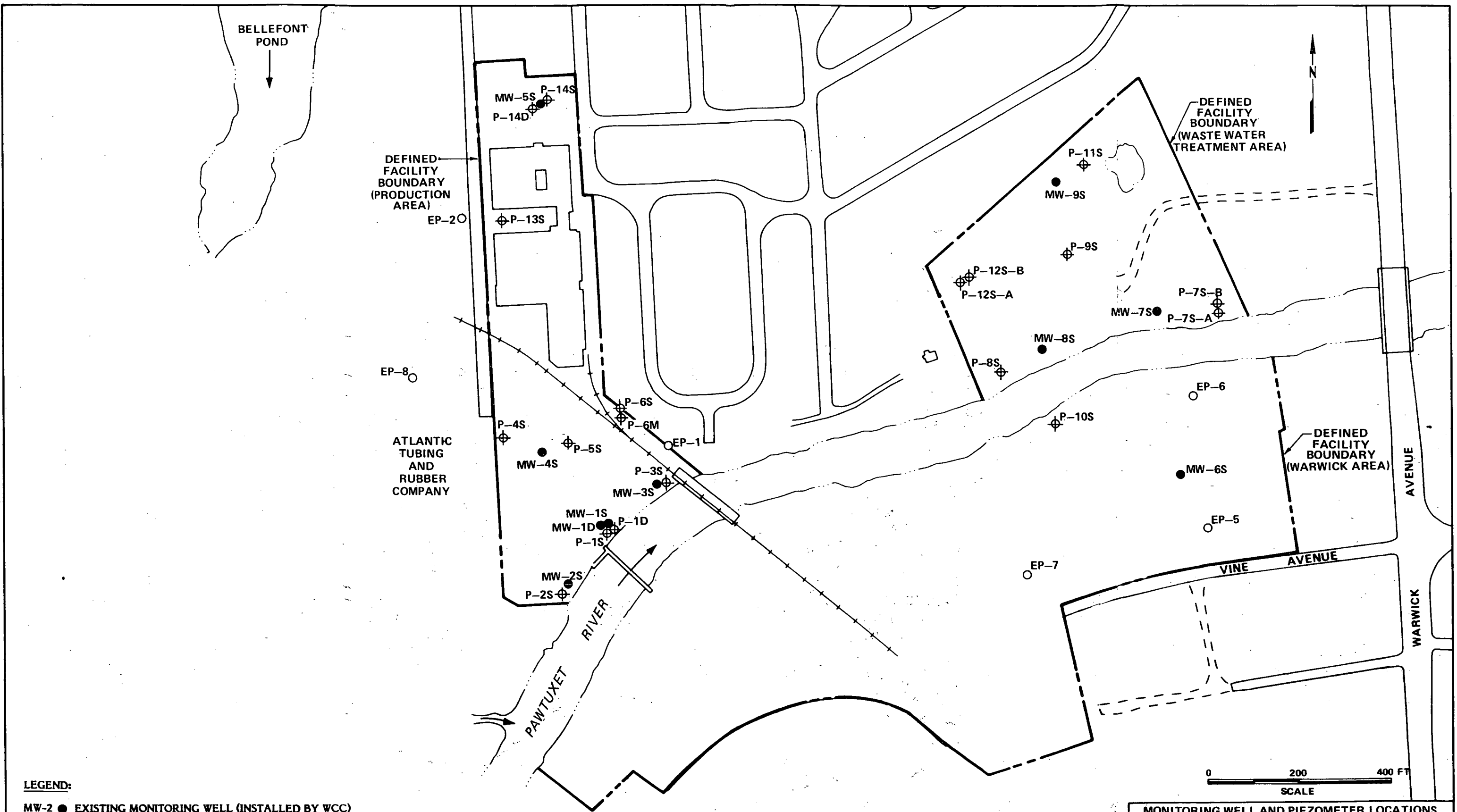
BASE MAP SOURCE: GEOD CORPORATION OF NEWFOUNDLAND, NEW JERSEY. MAPPED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS. DATE FLOWN: 2 APRIL 1989

LOCATION OF GEOLOGIC CROSS-SECTIONS  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

**WOODWARD - CLYDE CONSULTANTS**

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

DESIGN: KF	SCALE: 1:2400	PROJ. NO.: 87X4660
CHECKED: CJM	DATE: 1 AUG 1989	FIG. NO.: 2-11



**LEGEND:**

- MW-2 ● EXISTING MONITORING WELL (INSTALLED BY WCC)
- P-1S ⊕ EXISTING PIEZOMETER (INSTALLED BY WCC)
- EP-4 ○ EXISTING PIEZOMETER (INSTALLED BY CIBA-GEIGY)

NOTE: MONITORING WELL AND PIEZOMETER LOCATIONS BASED ON SURVEY BY WATERMAN ENGINEERING COMPANY OF EAST PROVIDENCE, RHODE ISLAND.

BASE MAP SOURCE: GEOD CORPORATION OF NEWFOUNDLAND, NEW JERSEY. MAPPED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS. DATE FLOWN: 2 APRIL 1989

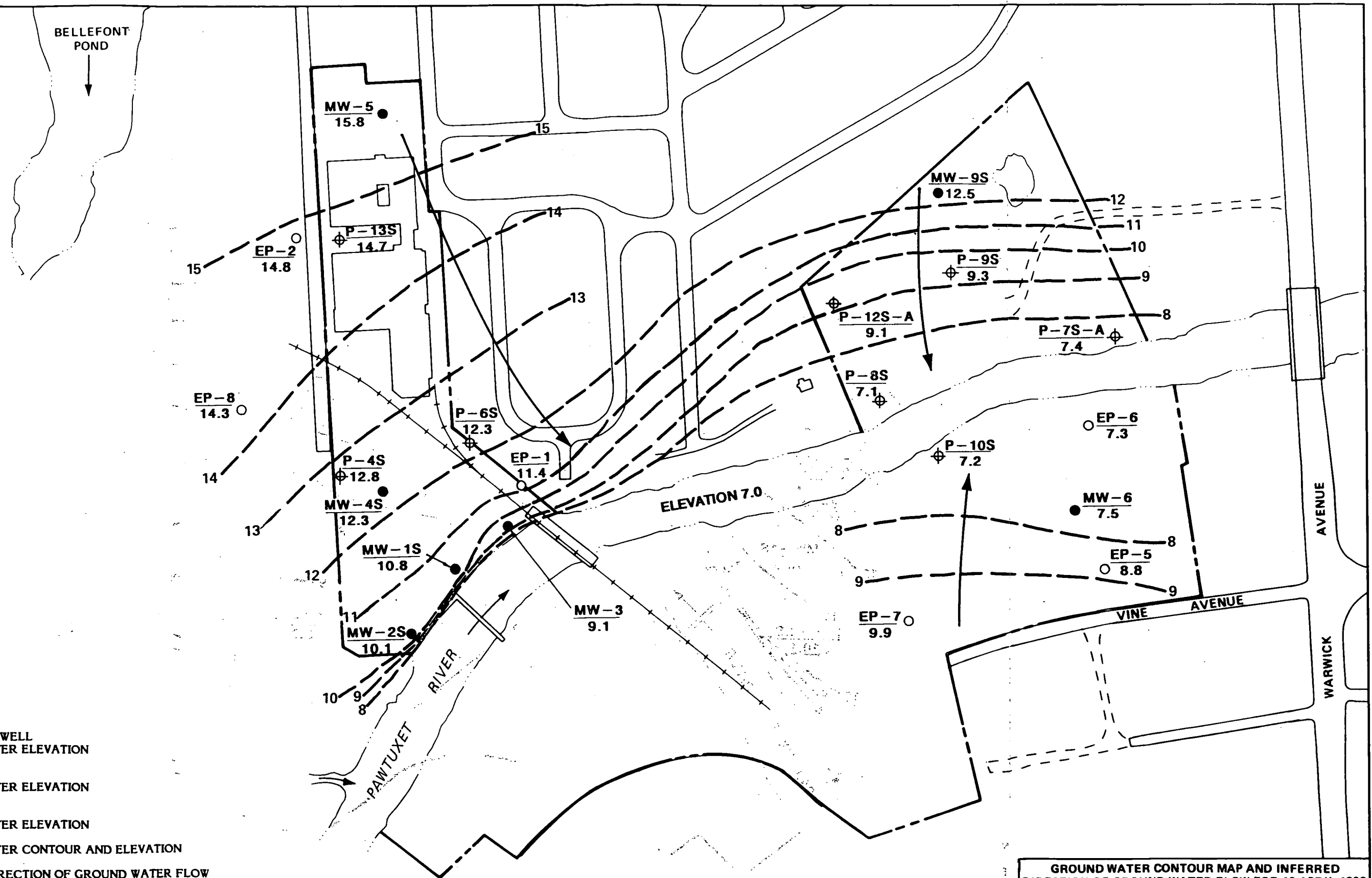
MONITORING WELL AND PIEZOMETER LOCATIONS  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

**WOODWARD - CLYDE CONSULTANTS**

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

DR. BY: KF	SCALE: 1:2400	PROJ. NO.: 87X4660
CK'D. BY: MH	DATE: 22 JUN 1989	FIG. NO.: 2-12





# LEGEND:

- MW-5 ● MONITORING WELL  
15.8 GROUND WATER ELEVATION
- EP-2 ○ PIEZOMETER  
14.8 GROUND WATER ELEVATION
- P-6S ⊕ PIEZOMETER  
12.3 GROUND WATER ELEVATION
- 9 — GROUND WATER CONTOUR AND ELEVATION
- INFERRED DIRECTION OF GROUND WATER FLOW

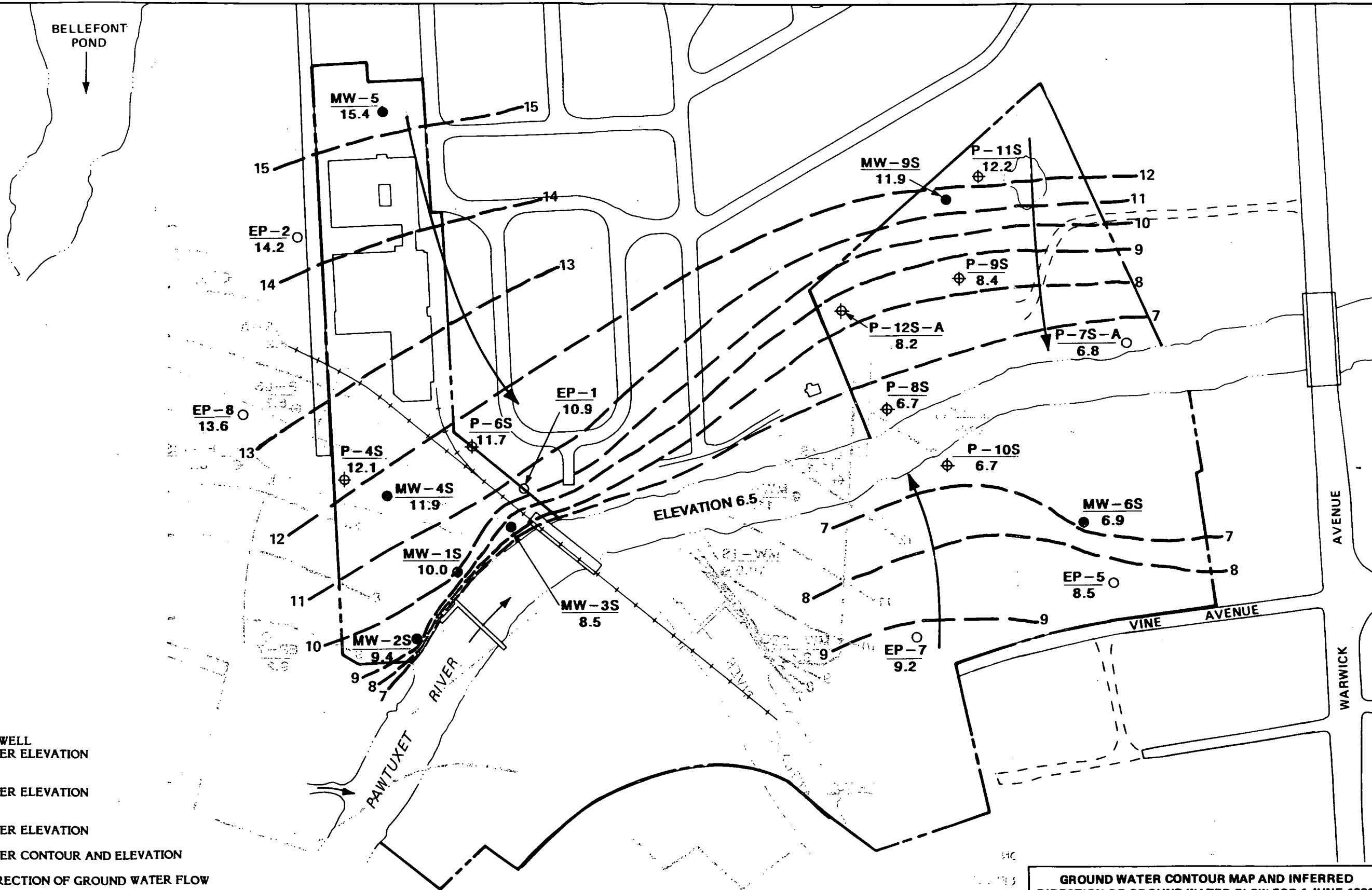
## NOTE

1. THE GROUND WATER CONTOURS SHOWN REPRESENT OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA.
2. ELEVATIONS ARE REPORTED IN FEET AND REFERENCED TO MEAN SEA LEVEL.

0 200 400 FT  
SCALE

BASE MAP SOURCE: GEOD CORPORATION OF NEWFOUNDLAND, NEW JERSEY. MAPPED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS. DATE FLOWN: 2 APRIL 1989

GROUND WATER CONTOUR MAP AND INFERRED DIRECTION OF GROUND WATER FLOW FOR 19 APRIL 1989 CIBA-GEIGY FACILITY CRANSTON, RHODE ISLAND		
<b>WOODWARD - CLYDE CONSULTANTS</b> CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS WAYNE, NEW JERSEY		
DR. BY: KF	SCALE: 1:2400	PROJ. NO.: 87X4660
CK'D. BY: CJM	DATE: 7 JULY 1989	FIG. NO.: 2-13

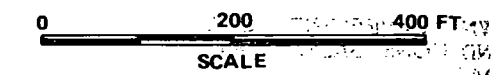


**LEGEND:**

- MW-5** ● **15.4** MONITORING WELL  
GROUND WATER ELEVATION
- EP-2** ○ **14.2** PIEZOMETER  
GROUND WATER ELEVATION
- P-6S** ⊕ **11.7** PIEZOMETER  
GROUND WATER ELEVATION
- 9** — GROUND WATER CONTOUR AND ELEVATION
- ➔ INFERRED DIRECTION OF GROUND WATER FLOW

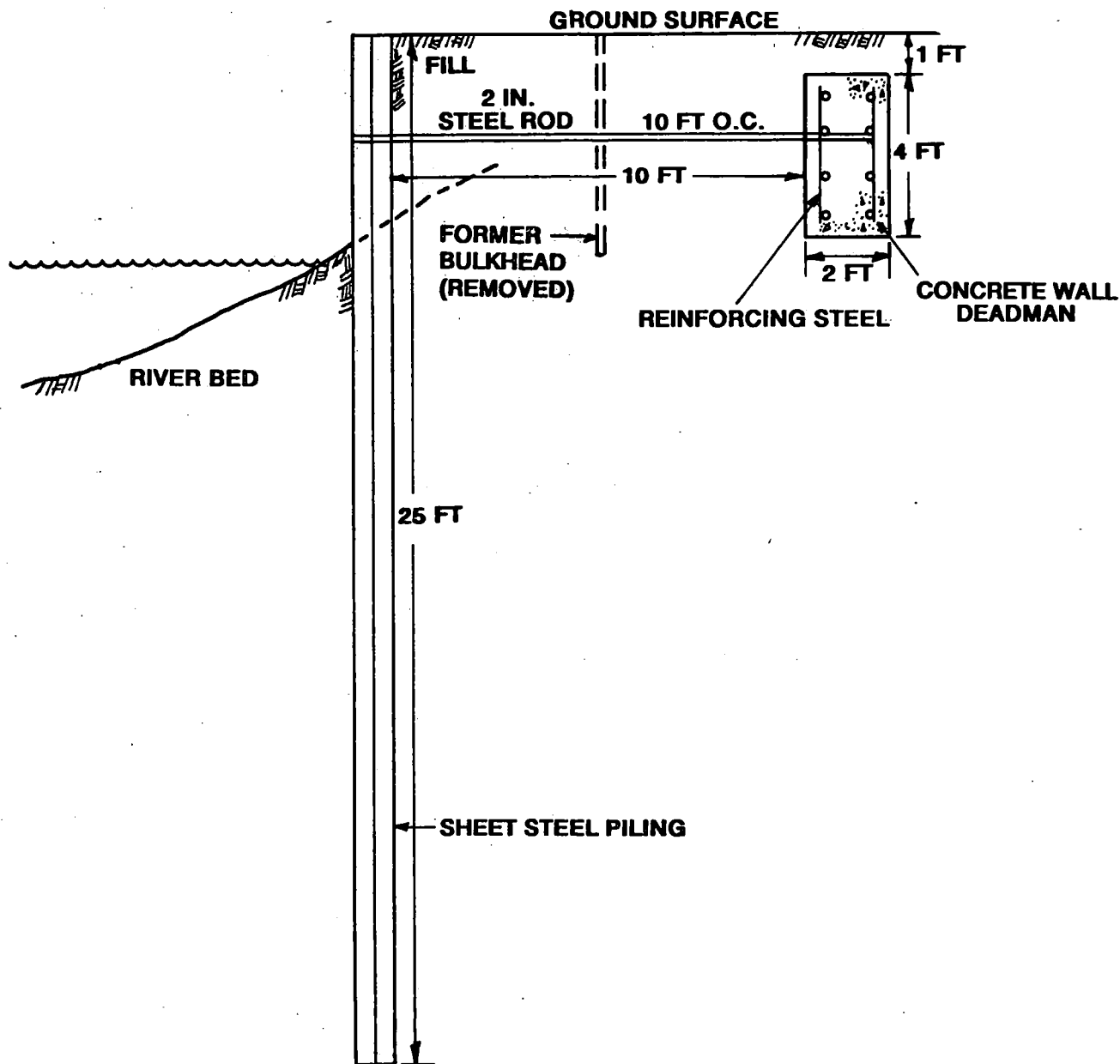
**NOTE**

1. THE GROUND WATER CONTOURS SHOWN REPRESENT OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA.
2. ELEVATIONS ARE REPORTED IN FEET AND REFERENCED TO MEAN SEA LEVEL.



BASE MAP SOURCE: GEOD CORPORATION OF NEWFOUNDLAND, NEW JERSEY. MAPPED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS. DATE FLOWN: 2 APRIL 1989

GROUND WATER CONTOUR MAP AND INFERRED DIRECTION OF GROUND WATER FLOW FOR 1 JUNE 1989 CIBA-GEIGY FACILITY CRANSTON, RHODE ISLAND		
<b>WOODWARD - CLYDE CONSULTANTS</b> CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS WAYNE, NEW JERSEY		
DR. BY: KF	SCALE: 1:2400	PROJ. NO.: 87X4660
CK'D. BY: CJM	DATE: 6 JULY 1989	FIG. NO.: 2-14



**PAWTUXET RIVER BULKHEAD CROSS-SECTION**  
**CIBA-GEIGY FACILITY**  
**CRANSTON, RHODE ISLAND**

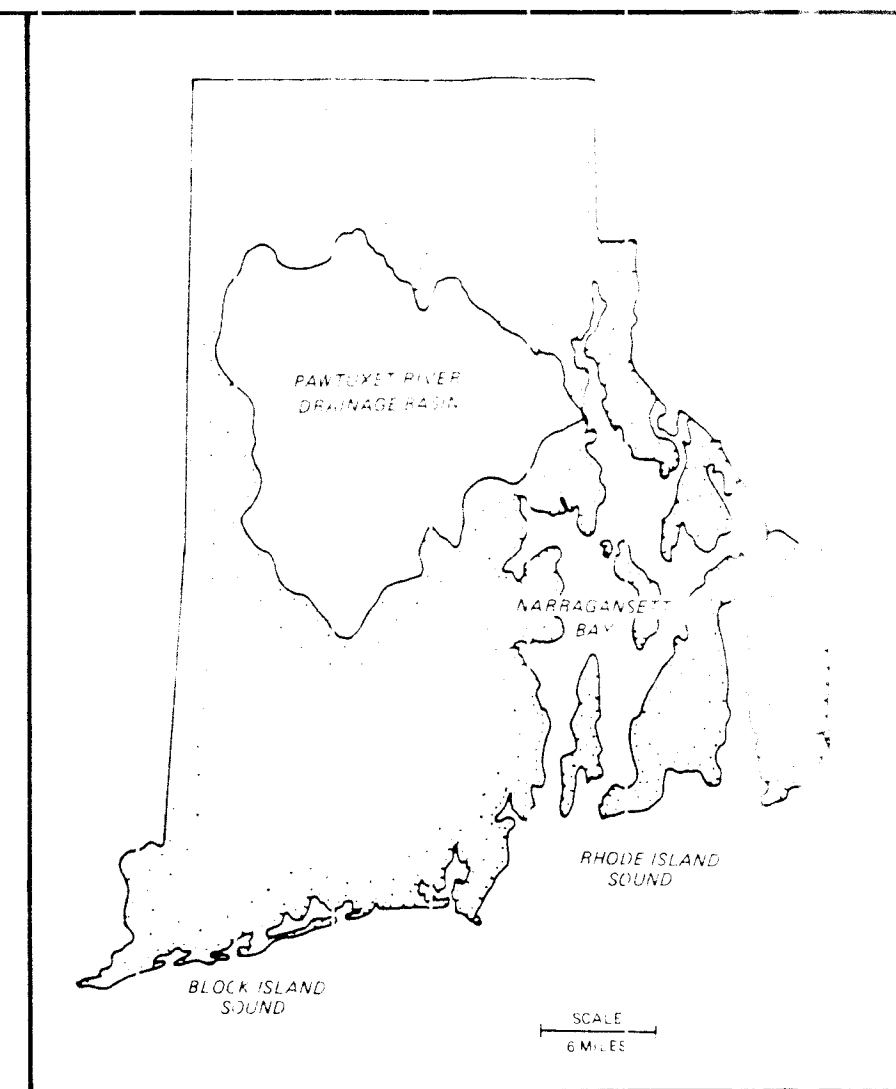
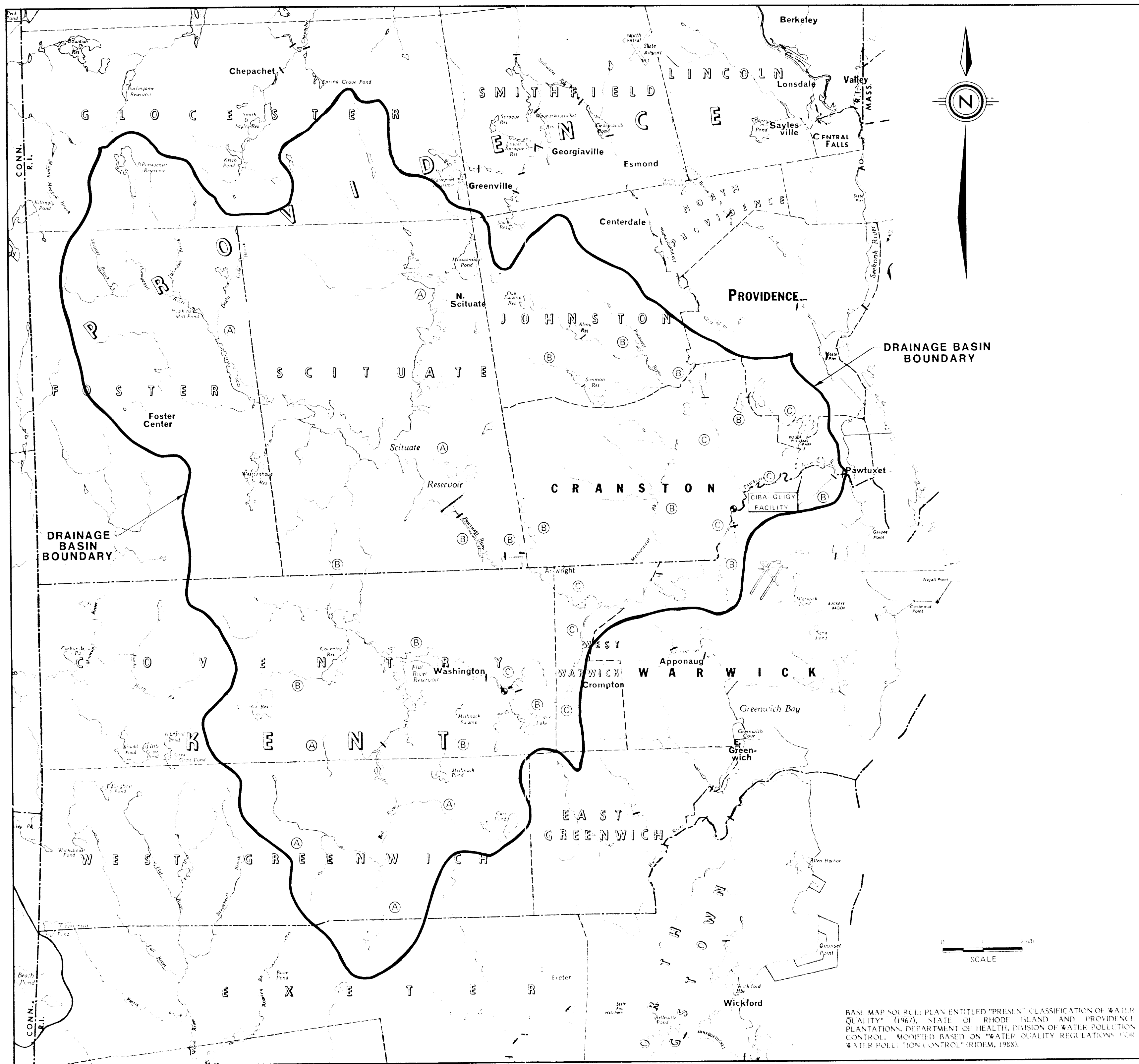
**WOODWARD - CLYDE CONSULTANTS**

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
 WAYNE, NEW JERSEY

DR. BY: BAS	SCALE: AS SHOWN	PROJ. NO.: 87X4660
CK'D. BY: CT	DATE: 22 FEB 1990	FIG. NO.: 2-15

**SOURCE:**

LAWRENCE H. McLEAN, 4 OCTOBER 1955,  
 PLOT PLAN RIVER BULKHEAD ALROSE CHEMICAL  
 COMPANY, CRANSTON, RHODE ISLAND.

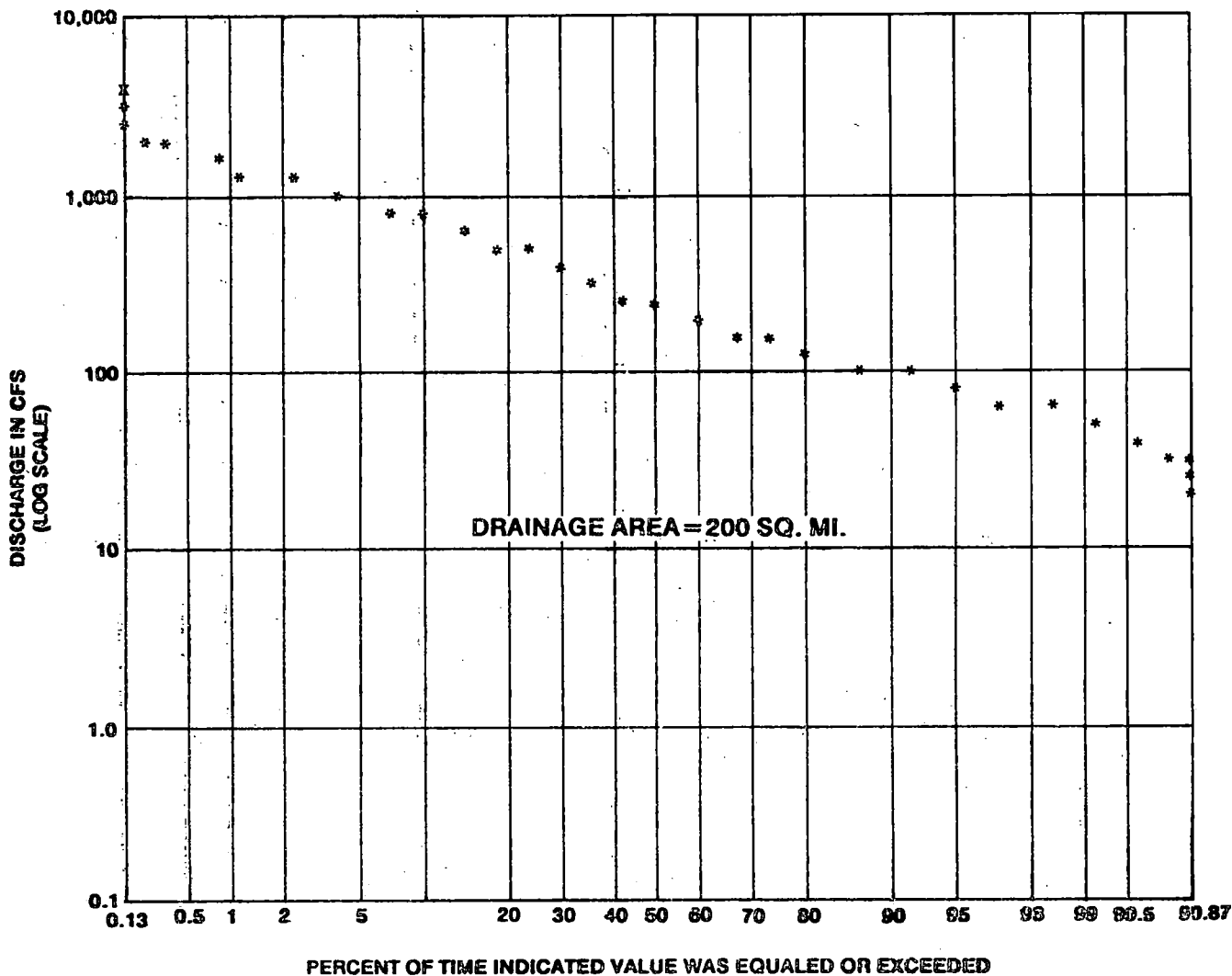


- LEGEND
- (A) WATER QUALITY CLASS
  - 9 LOCATION OF USGS GAUGING STATION

NOTE: THE MAIN STEM OF THE PAWTUXET RIVER HAS A CLASS A STANDARD BUT IS CONSIDERED CLASS D DOWNSTREAM OF CROMPTON FALLS.

PAWTUXET RIVER DRAINAGE BASIN WATER CLASSIFICATION AND LOCATION OF USGS GAUGING STATION CIBA-GEIGY FACILITY CRANSTON, RHODE ISLAND			
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS WAYNE, NEW JERSEY			
DR. BY	KE	SCALE	AS SHOWN
CK'D BY	GJM	DATE	21 JUN 1989
PROJ. NO.	7	FIG. NO.	7

BASIS MAP SOURCE: PLAN ENTITLED "PRESENT CLASSIFICATION OF WATER QUALITY" (1967), STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS, DEPARTMENT OF HEALTH, DIVISION OF WATER POLLUTION CONTROL. MODIFIED BASED ON "WATER QUALITY REGULATIONS FOR WATER POLLUTION CONTROL" (RIDEM, 1988).



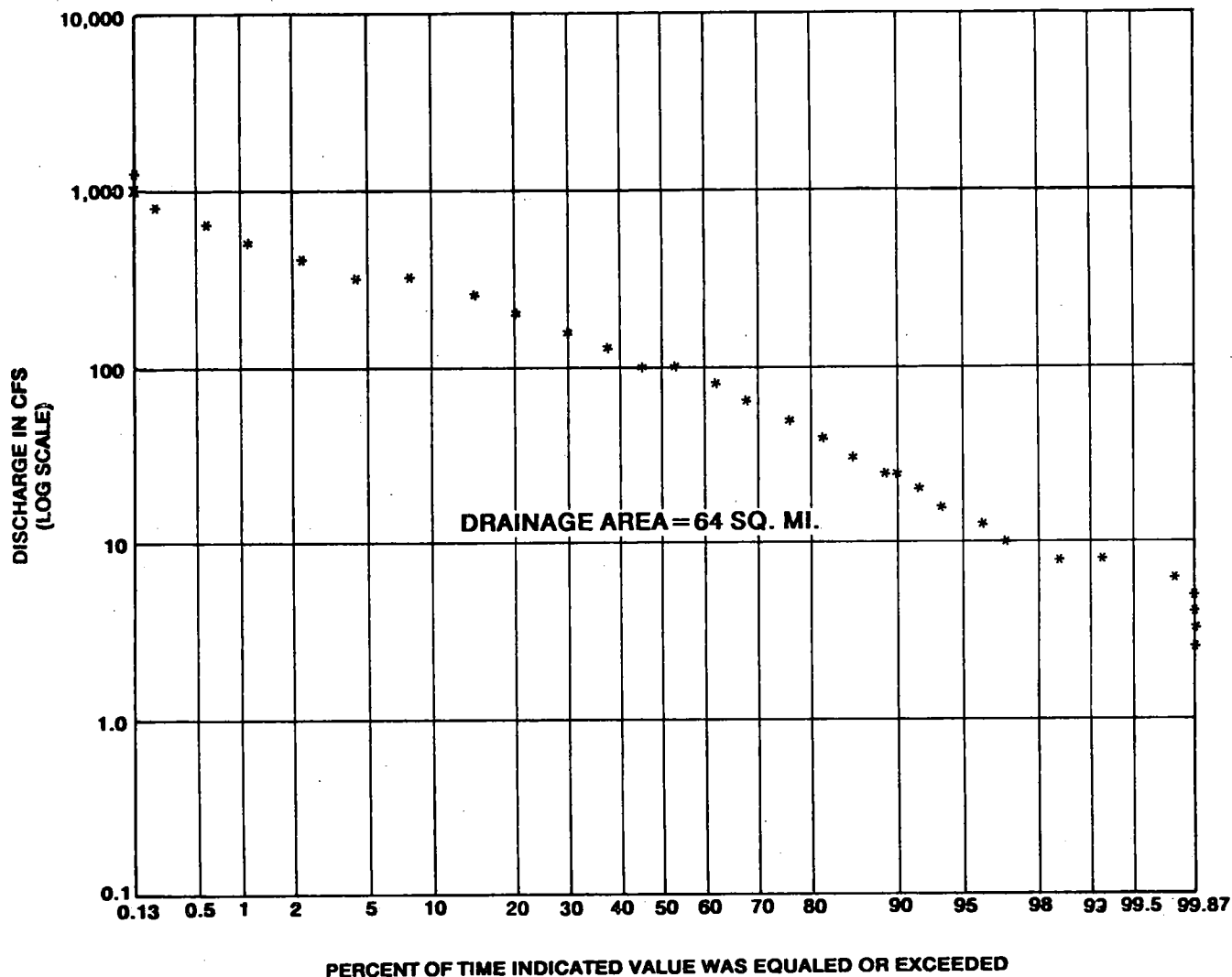
**NOTES:**

1. PERIOD OF RECORD IS FROM 1941 TO 1985.
2. SQ. MI. = SQUARE MILES
3. \* = SINGLE POINT
4. x = MULTIPLE POINTS

**SOURCE:**

USGS, 1990

<b>TIME DURATION CURVE</b> <b>PAWTUXET RIVER DISCHARGE</b> <b>CRANSTON, RHODE ISLAND</b> <b>CIBA - GEIGY FACILITY</b> <b>CRANSTON, RHODE ISLAND</b>		
<b>WOODWARD - CLYDE CONSULTANTS</b> CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS WAYNE, NEW JERSEY		
DR. BY: KF	SCALE: AS SHOWN	PROJ. NO.: 87X4660
CHK'D. BY: CWT	DATE: 19 SEPT 1980	FIG. NO.: 2-17



**NOTES:**

1. PERIOD OF RECORD IS FROM 1941 TO 1985.
2. SQ. MI. = SQUARE MILES
3. \* = SINGLE POINT
4. x = MULTIPLE POINTS

**SOURCE:**

USGS, 1990

<b>TIME DURATION CURVE</b> <b>PAWTUXET RIVER DISCHARGE</b> <b>WASHINGTON, RHODE ISLAND</b> <b>CIBA-GEIGY FACILITY</b> <b>CRANSTON, RHODE ISLAND</b>		
<b>WOODWARD - CLYDE CONSULTANTS</b> CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS WAYNE, NEW JERSEY		
DR. BY: KF	SCALE: AS SHOWN	PROJ. NO.: 87X4660
CK'D. BY: CWT	DATE: 14 FEB 1990	FIG. NO.: 2-18

BELLEFONT POND

DEFINED FACILITY BOUNDARY (PRODUCTION AREA)

DEFINED FACILITY BOUNDARY (WASTE WATER TREATMENT AREA)

ATLANTIC TUBING AND RUBBER COMPANY

DEFINED FACILITY BOUNDARY (WARWICK AREA)

# BUILDING LEGEND

- 10/18 BOILER ROOM
- 11 PRODUCTION BUILDING
- 14 OFFICE BUILDING
- 15 WAREHOUSE
- 16 PILOT PLANT
- 17 DRYING, GRINDING & BLENDING
- 19 MANUFACTURING BUILDING
- 20 LABORATORY BUILDING
- 21 PROCESS BUILDING
- 22 MANUFACTURING BUILDING
- 23 PILOT PLANT
- 24 BUILDING (ZINC ISOLATION)
- 25 WAREHOUSE
- 26 LABORATORY BUILDING
- 27 WATER RECOVERY BUILDING
- 30 LOCKER ROOM
- 31 CAFETERIA
- 32 DRUM STORAGE WAREHOUSE
- 33 MAINTENANCE WAREHOUSE
- 35 MAINTENANCE BUILDING
- 37 EFFLUENT TREATMENT HEAD WORKS BUILDING

# OTHER STRUCTURES

- TF TANK FARM
- ORTF OVER THE RIVER TANK FARM

- 1 HAZARDOUS WASTE STORAGE AREA
- 2 WASTE WATER EQUALIZATION TANK
- 3 WASTE WATER EQUALIZATION TANK
- 4 WASTE WATER EQUALIZATION TANK
- 5 TRICKLING TOWER
- 6 TRICKLING TOWER
- 7 COOLING TOWER
- 38 FLUME
- 39 CLARIFIER

NOTE: DASHED LINE INDICATES FORMER STRUCTURE. SOLID LINE INDICATES EXISTING STRUCTURE. LOCATIONS SHOWN ARE APPROXIMATE. BASE MAP SOURCE: GEOD CORPORATION OF NEWFOUNDLAND, NEW JERSEY. MAPPED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS. DATE FLOWN: 2 APRIL 1989

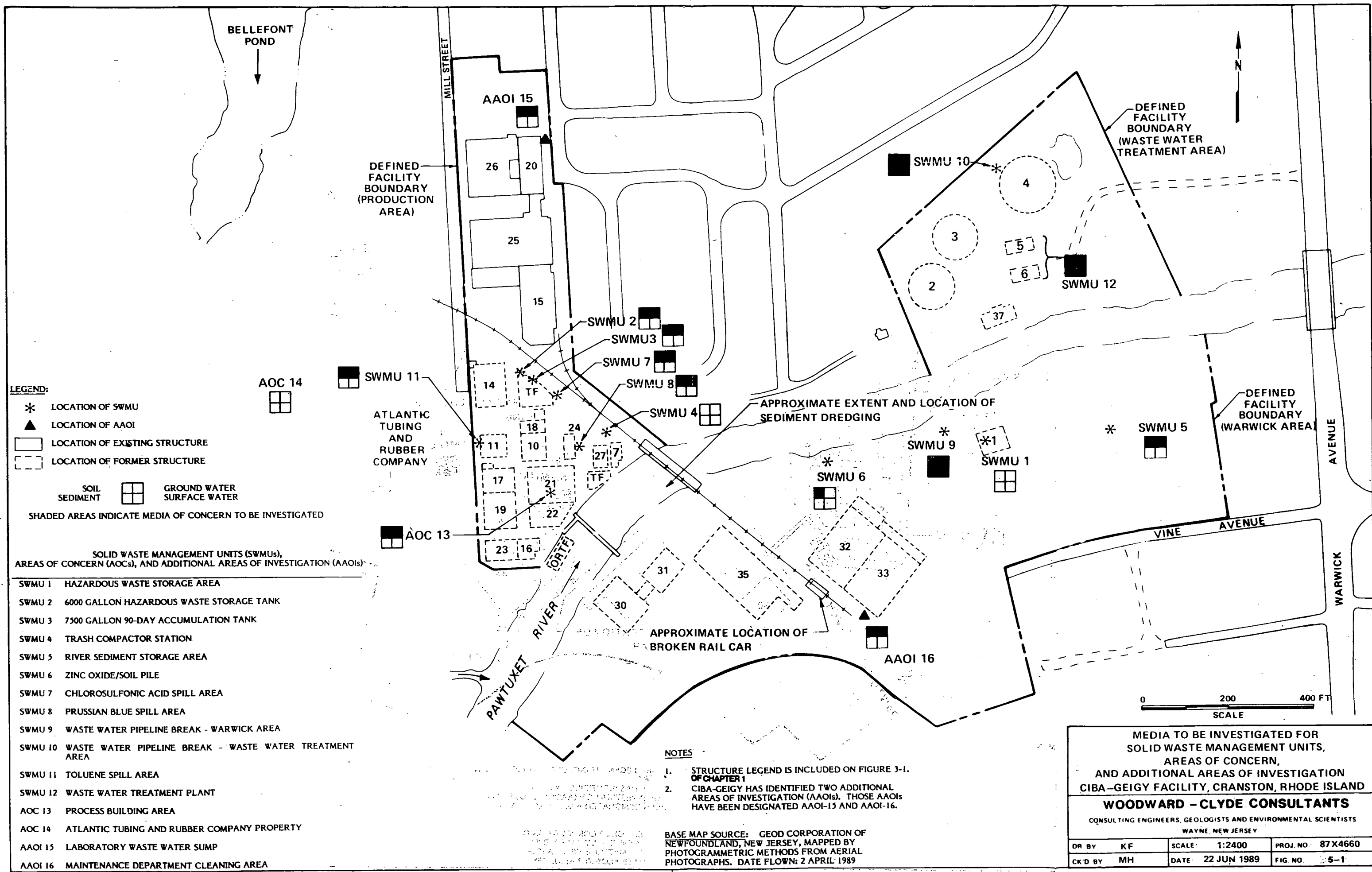
EXISTING AND FORMER STRUCTURES  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

**WOODWARD - CLYDE CONSULTANTS**

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

DR. BY: KF	SCALE: 1:2400	PROJ. NO.: 87X4660
CK'D. BY: MH	DATE: 22 JUN 1989	FIG. NO.: 3-1





**LEGEND:**

- \* LOCATION OF SWMU
- ▲ LOCATION OF AAOI
- LOCATION OF EXISTING STRUCTURE
- LOCATION OF FORMER STRUCTURE
- SOIL SEDIMENT
- GROUND WATER SURFACE WATER
- SHADED AREAS INDICATE MEDIA OF CONCERN TO BE INVESTIGATED

**SOLID WASTE MANAGEMENT UNITS (SWMUs), AREAS OF CONCERN (AOCs), AND ADDITIONAL AREAS OF INVESTIGATION (AAOIs):**

SWMU 1	HAZARDOUS WASTE STORAGE AREA
SWMU 2	6000 GALLON HAZARDOUS WASTE STORAGE TANK
SWMU 3	7500 GALLON 90-DAY ACCUMULATION TANK
SWMU 4	TRASH COMPACTOR STATION
SWMU 5	RIVER SEDIMENT STORAGE AREA
SWMU 6	ZINC OXIDE/SOIL PILE
SWMU 7	CHLOROSULFONIC ACID SPILL AREA
SWMU 8	PRUSSIAN BLUE SPILL AREA
SWMU 9	WASTE WATER PIPELINE BREAK - WARWICK AREA
SWMU 10	WASTE WATER PIPELINE BREAK - WASTE WATER TREATMENT AREA
SWMU 11	TOLUENE SPILL AREA
SWMU 12	WASTE WATER TREATMENT PLANT
AOC 13	PROCESS BUILDING AREA
AOC 14	ATLANTIC TUBING AND RUBBER COMPANY PROPERTY
AAOI 15	LABORATORY WASTE WATER SUMP
AAOI 16	MAINTENANCE DEPARTMENT CLEANING AREA

**NOTES**

1. STRUCTURE LEGEND IS INCLUDED ON FIGURE 3-1, OF CHAPTER 1
2. CIBA-GEIGY HAS IDENTIFIED TWO ADDITIONAL AREAS OF INVESTIGATION (AAOIs). THOSE AAOIs HAVE BEEN DESIGNATED AAOI-15 AND AAOI-16.

BASE MAP SOURCE: GEOD CORPORATION OF NEWFOUNDLAND, NEW JERSEY, MAPPED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS. DATE FLOWN: 2 APRIL 1989

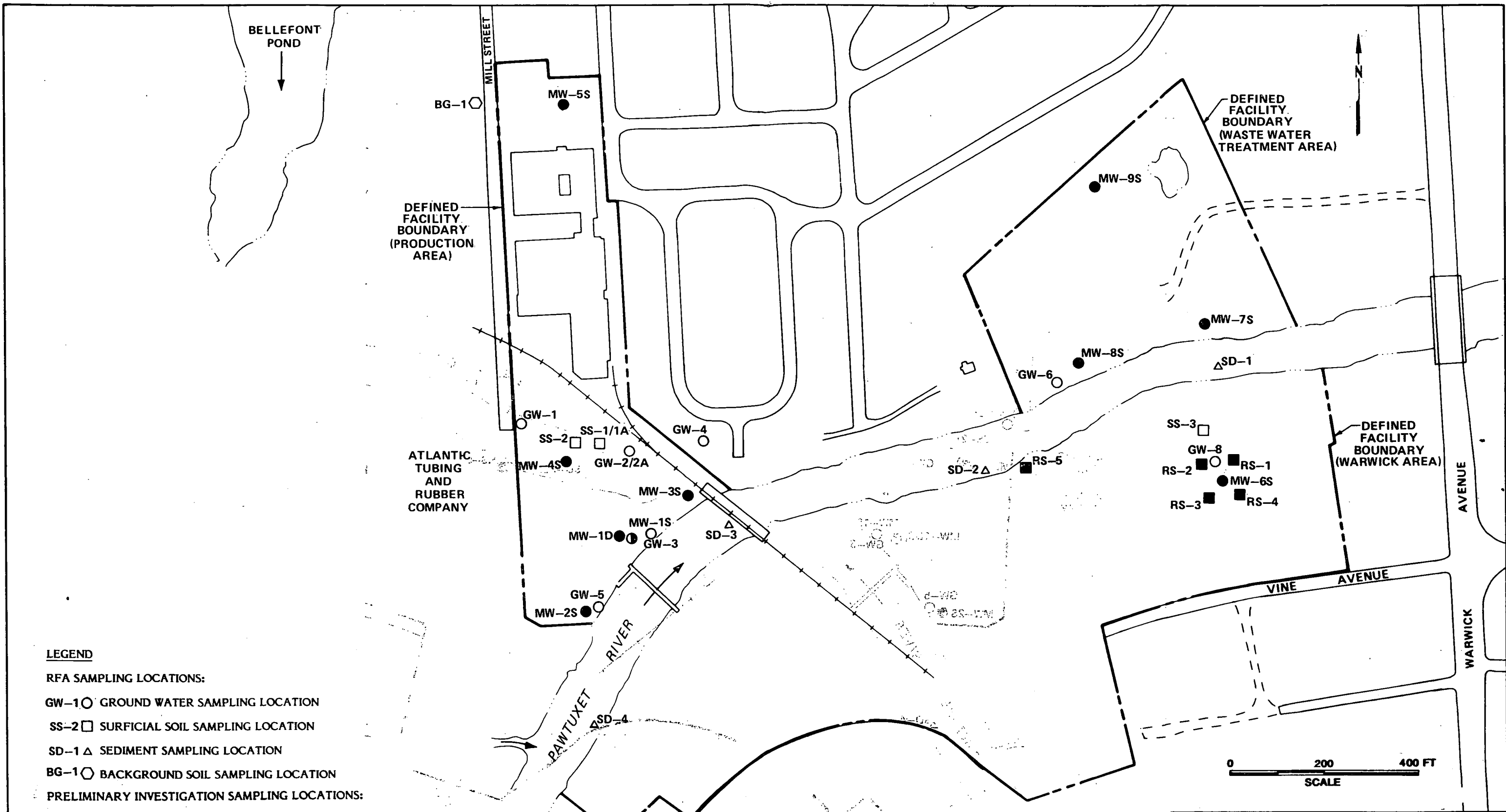
**MEDIA TO BE INVESTIGATED FOR SOLID WASTE MANAGEMENT UNITS, AREAS OF CONCERN, AND ADDITIONAL AREAS OF INVESTIGATION**

**CIBA-GEIGY FACILITY, CRANSTON, RHODE ISLAND**

**WOODWARD - CLYDE CONSULTANTS**

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

DR BY	KF	SCALE	1:2400	PROJ. NO.	87X4660
CK'D BY	MH	DATE	22 JUN 1989	FIG. NO.	5-1



**LEGEND**

**RFA SAMPLING LOCATIONS:**

- GW-1 ○ GROUND WATER SAMPLING LOCATION
- SS-2 □ SURFICIAL SOIL SAMPLING LOCATION
- SD-1 △ SEDIMENT SAMPLING LOCATION
- BG-1 ○ BACKGROUND SOIL SAMPLING LOCATION

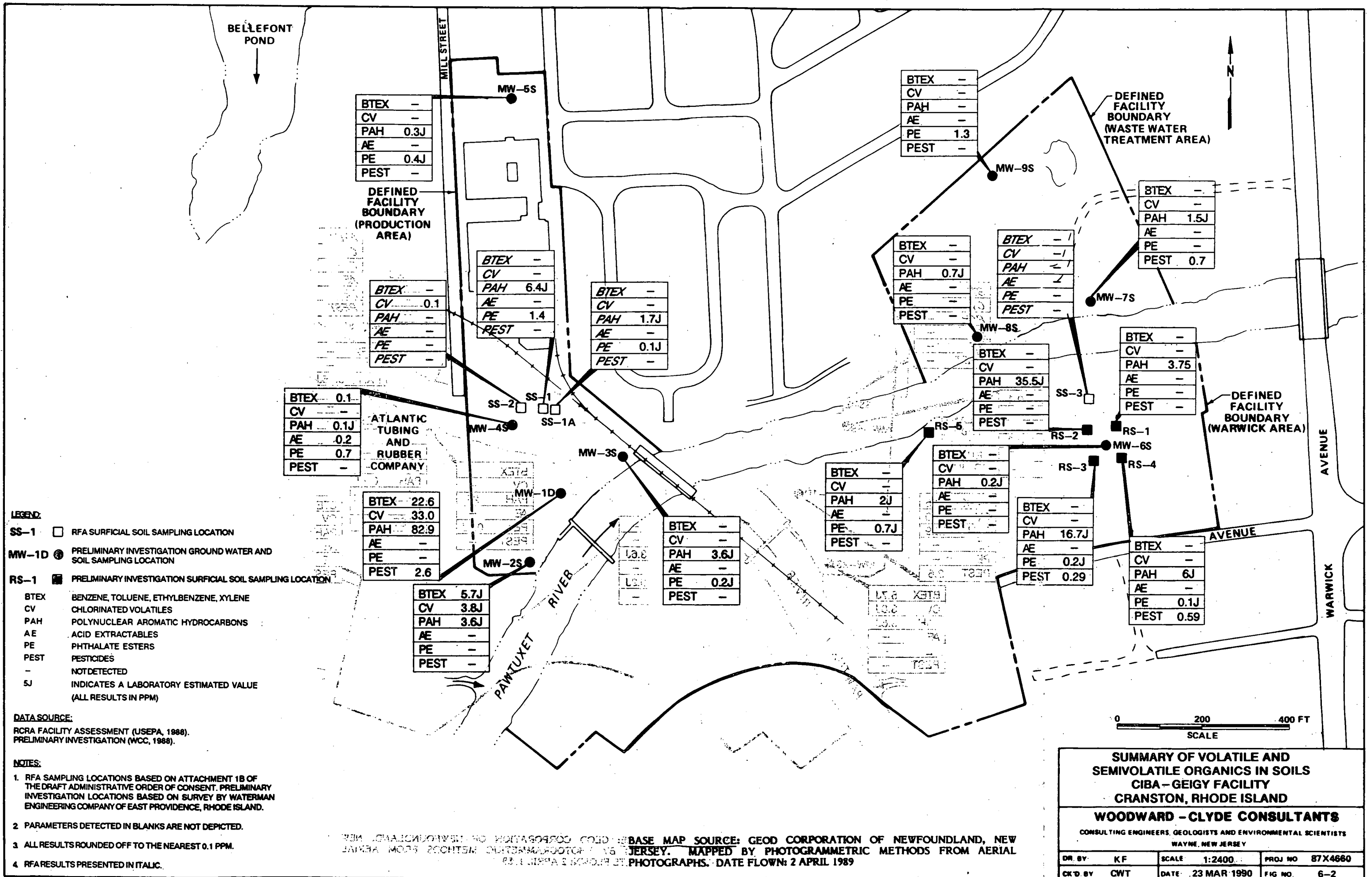
**PRELIMINARY INVESTIGATION SAMPLING LOCATIONS:**

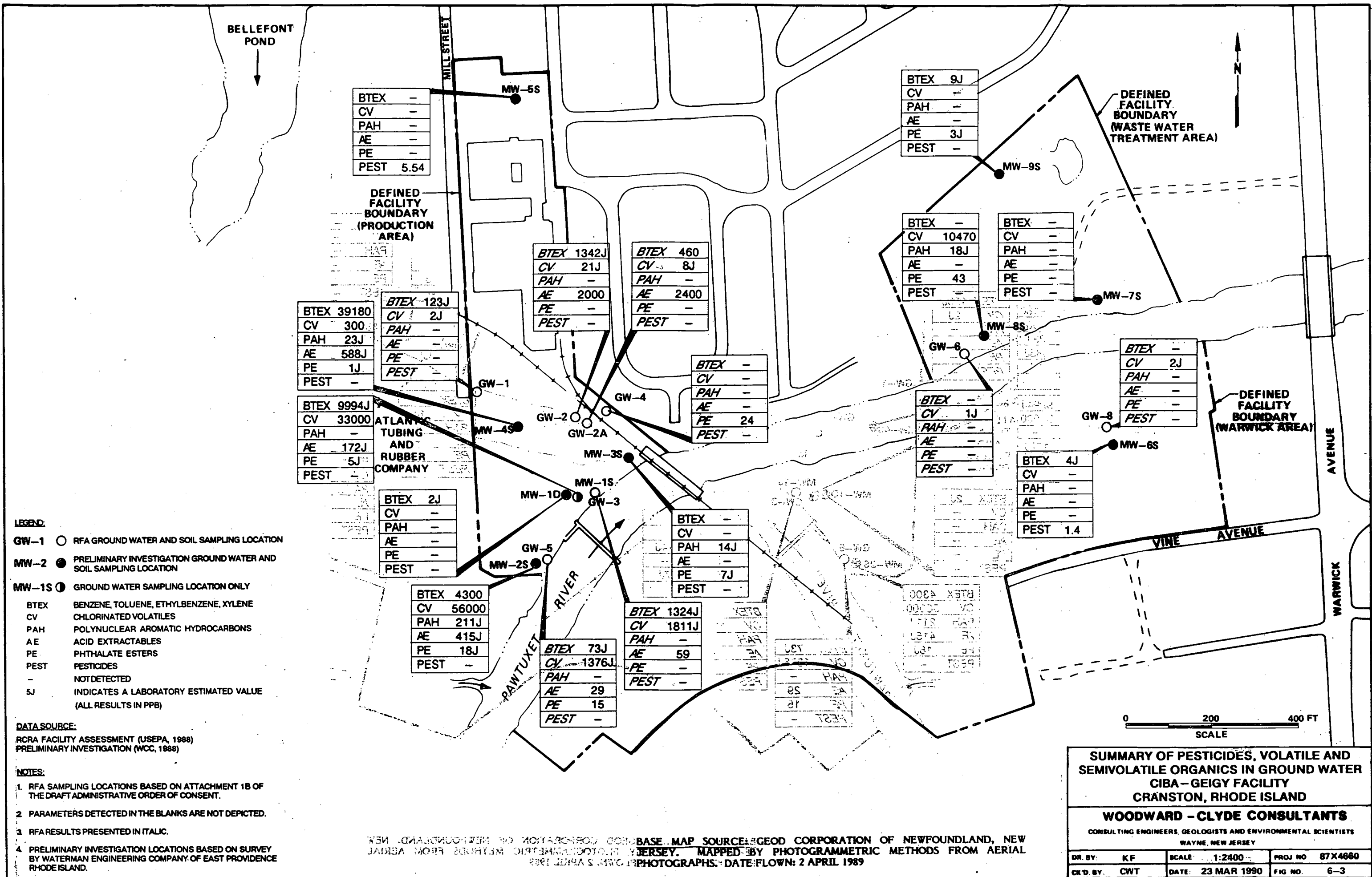
- MW-2 ● GROUND WATER AND SOIL SAMPLING LOCATION
- RS-1 ■ SURFICIAL SOIL SAMPLING LOCATION
- MW-1S ● GROUND WATER SAMPLING LOCATION ONLY

NOTE: RFA SAMPLING LOCATIONS BASED ON ATTACHMENT 1B OF THE DRAFT ADMINISTRATIVE ORDER ON CONSENT. LOCATIONS SHOWN ARE APPROXIMATE. PRELIMINARY INVESTIGATION LOCATIONS BASED ON SURVEY BY WATERMAN ENGINEERING COMPANY OF EAST PROVIDENCE, RHODE ISLAND.

BASE MAP SOURCE: GEOD CORPORATION OF NEWFOUNDLAND, NEW JERSEY. MAPPED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS. DATE FLOWN: 2 APRIL 1989

<b>RFA AND PRELIMINARY INVESTIGATION SAMPLING LOCATIONS CIBA-GEIGY FACILITY CRANSTON, RHODE ISLAND</b>		
<b>WOODWARD - CLYDE CONSULTANTS</b> CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS WAYNE, NEW JERSEY		
DR. BY: KF	SCALE: 1:2400	PROJ. NO.: 87X4680
CK'D. BY: MH	DATE: 22 JUN 1989	FIG. NO.: 6-1





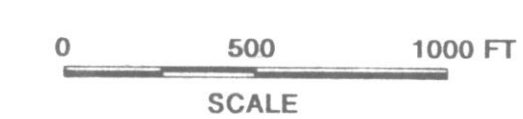




LEGEND:  
3 ■ OFF SITE SURFICIAL SOIL SAMPLING LOCATION

NOTES:  
1. SAMPLING LOCATIONS BASED ON VERSAR (1988) AND RIDEM (1986, 1987).  
2. SAMPLES COLLECTED BY RIDEM (DIVISION OF AIR AND HAZARDOUS MATERIALS).  
3. SAMPLING LOCATION 2 WAS RESAMPLED AND DESIGNATED 2A.  
4. SAMPLE 7 WAS COLLECTED IN ROGER WILLIAMS PARK.  
5. SAMPLING LOCATIONS A, B, C, D, RT AND OT WERE NOT INDICATED ON ANY OF THE MAPS PRESENTED BY VERSAR (1988) OR RIDEM (1986, 1987). THE LOCATIONS WERE DESCRIBED AS FOLLOWS:  
A RURAL LOCATION - NORTH KINGSTON  
B EAST SIDE - PROVIDENCE  
C MOUNT PLEASANT - PROVIDENCE  
D BUTTONWOODS - WARWICK  
RT RED TOMATO (GROWN NEAR FACILITY), AND  
OT ORANGE TOMATO (GROWN NEAR FACILITY)

BASE MAP SOURCE:  
USGS PROVIDENCE QUADRANGLE (1975)



RFA OFF-SITE SOIL SAMPLING LOCATIONS CIBA-GEIGY FACILITY CRANSTON, RHODE ISLAND			
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS WAYNE, NEW JERSEY			
DR. BY:	KF	SCALE:	1:6000
CK'D. BY:	CJM	DATE:	7 JUN 1989
PROJ. NO.:	87X4660	FIG. NO.:	6-4



## **Appendix A**

**VOLUME 1 - CHAPTER 1**  
**APPENDIX A**  
**BORING LOGS AND CONSTRUCTION DETAILS**  
**MONITORING WELLS AND PIEZOMETERS**

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## BORING LOGS

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AM89-149A

**WOODWARD-CLYDE CONSULTANTS**  
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LOG OF BORING MW-25

SHEET 1 OF 2

PROJECT AND LOCATION <b>CIBA - PEIGY, Cranston, R.I.</b>				ELEVATION AND DATUM <b>12.54' MSL</b>		PROJECT NO. <b>87X4660</b>	
DRILLING AGENCY <b>Soil Exploration</b>				FOREMAN <b>Mark Zink</b>		DATE STARTED <b>5/17/88</b>	
DRILLING EQUIPMENT <b>TRUCK-MOUNTED DRILLING RIG</b>				COMPLETION DEPTH <b>20 FT</b>		ROCK DEPTH <b>NOT ENCOUNTERED</b>	
SIZE AND TYPE OF BIT <b>8 1/4" ID HSA</b>		SIZE AND TYPE CORE BARREL		NO SAMPLES <b>2</b>		DIST <b>2</b>	
CASING <b>2 IN. O.D. SPLIT SPOON</b>				WATER LEVEL <b>FIAT ≈ 5'</b>		UNDIST <b>2</b>	
CASING HAMMER		WEIGHT		DROP		BORING ANGLE AND DIRECTION <b>VERTICAL</b>	
SAMPLER HAMMER		WEIGHT <b>140 LBS.</b>		DROP <b>30 IN.</b>		INSPECTOR <b>R. J. Henning</b>	

DESCRIPTION	PIEZOMETER	DEPTH, FT	SAMPLES				HNU READINGS (PPM)				REMARKS
			NO.	RECOV. FT.	PENETR. RESIST. BL/6 IN.	TIME	SAMP. LE	AMBI- ENT AIR	TIME		
Fill, f. sand, bricks, f. gravel to c. gravel,	R	1								Classification of soil from 0-3.5' and from 7.5-20' was noted on the return of soil cuttings.	
		2									
		3									
Fill, c. sand, bricks, clay tile, some r.f. gravel, black matrix, few c. gravel	S	4								Black ooze above and below water table, some sheen	
		5	S-1	0.5'	5324	1030	10	0.8			
		6	S-2	0.3'	6454	1025	10	0.8			
Same as above	E	7								Combined samples S-1 and S-2 into one sample.	
		8									
		9									
Same as above	N	10									
		11									
		12									
finer SAND,	R	13									
		14									
		15									
Medium SILT with some coarse sand	E	16									
		17									
		18									
finer SAND,	N	19									
		20									

SHEET 1 OF 2

Piez f-m silty SAND, wet

SHEET 1 OF 1

PROJECT AND LOCATION		ELEVATION AND DATUM		PROJECT NO					
CIBA GEIGY, Cranston, RI		18.24' MSL		87X4660					
DRILLING AGENCY		DATE STARTED		DATE FINISHED					
Soil Exploration		5/17/88		5/17/88					
DRILLING EQUIPMENT		COMPLETION DEPTH		ROCK DEPTH					
TRUCK-MOUNTED DRILLING RIG Acker Soil Map		19 FT		NOT ENCOUNTERED					
SIZE AND TYPE OF BIT		NO. SAMPLES		DIST					
4 1/4" ID HSA		10		10					
CASING		WATER LEVEL		FIRST					
NA		7.5'		7.5'					
CASING HAMMER		WEIGHT		DROP					
SAMPLER 2-3 IN. O.D. SPLIT SPOONS		SAMPLER HAMMER		WEIGHT 140 LBS.					
SAMPLER HAMMER		WEIGHT 140 LBS.		DROP 30 IN.					
BOILING ANGLE AND DIRECTION		INSPECTOR							
VERTICAL		MARK HOULDAY							
DESCRIPTION	FREQUENT	DEPTH, FT	SAMPLES			HNU READINGS (PPM)			REMARKS
			NO.	RECOVER. FT.	PENETR. RESIST. BL/GIN	SAMP. LE	AMBI- ENT AIR	TIME	
FILL, Brown to grey silty f SAND with gravel, moist	SER	1	S-1	1.1'	22 46 115 55	9 30			Sampling began at ~930 HNU - not working, shut in probe.
FILL, Brown to orange silty f SAND with gravel, moist		2	S-2	1.2'	23 26 27 35	9 50			
FILL, Brown silty f SAND with gravel, moist		3	S-3	0.7'	70 120 16	10 10			Refusal - building foundation? Moved borehole ~ 3'
FILL, Brown to orange to grey f sandy SILT with clay and gravel, moist		4	S-4	0.8'	5 7 7 12	10 30			
Grey to black to brown clayey SILT, moist to wet		5	S-5	0.5'	10 7 7 6	11 00			Hit water table at ~7.5' Composited samples S4/S5* and submitted for analysis.
Black to grey f sandy SILT (~12"), Black to grey clayey SILT (~6"), wet		6	S-6	1.5'	7 8 10 7	11 10			
Black to grey silty CLAY, thin lenses of grey f. sand, wet		7	S-7	1.3'	6 6 6 9	11 20			
Brown to grey f-m SAND (~14"), Grey silty clay (4"), wet		8	S-8	1.5'	6 7 8 11	11 30			
Black to grey f-m SAND, grey silty clay lenses, wet		9	S-9	1.7'	8 12 12	11 40			
Same as above		10	S-10	1.7'	13 17 15 14	11 50			

SHEET 1 OF 1

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NW-65

DESCRIPTION	PIEZOMETER	DEPTH, FT	SAMPLES				HNU READINGS (PPM)			REMARKS
			NO.	RECOV. FT	PENETR. RESIST. BL/6IN.	TIME	SAMPLE	AMBIENT AIR	TIME	
Grey - dark grey clayey SILT, wet		21	S-11	1.3'	7	935	0.8	0.8	10 <sup>30</sup>	
		22			7					
Grey - dark grey silty SAND (8")		23	S-12	1.3'	8	945	0.8	0.8	10 <sup>30</sup>	
Grey - dark grey clayey SILT (8")		24			20					
Grey of SAND with gravel, tr. silt, clay, wet		25	S-13	0.6'	5	952	0.8	0.8	10 <sup>30</sup>	
		26			12					
Grey clayey SILT, wet		27	S-14	1.6'	7	957	0.8	0.8	10 <sup>30</sup>	Completed corpling at ≈ 10 <sup>05</sup> AM. 5/18/88.
		28			80					
Same as above		29	S-15	1.8'	5	10 <sup>05</sup>	0.8	0.8	10 <sup>30</sup>	Terminated boring at 30'.
		30			10					



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LOG OF BORING.....MW-8S

SHEET...1...OF 2...

PROJECT AND LOCATION <b>CIBA - GEIGY, Cranston, RI</b>				ELEVATION AND DATUM <b>15.00' MSL</b>		PROJECT NO <b>87X4660</b>		
DRILLING AGENCY <b>Soil Exploration</b>			FOREMAN <b>MARK</b>		DATE STARTED <b>5/18/88</b>		DATE FINISHED <b>5/19/88</b>	
DRILLING EQUIPMENT <b>TRUCK-MOUNTED DRILLING RIG Acton - Soil Map</b>				COMPLETION DEPTH <b>30 FT</b>		ROCK DEPTH <b>NOT ENCOUNTERED</b>		
SIZE AND TYPE OF BIT <b>4 1/2" ID HSA</b>		SIZE AND TYPE CORE BARREL		NO. SAMPLES <b>15</b>		DIST <b>15</b>		
CASING <b>NA</b>				WATER LEVEL <b>FIRST 7.5'</b>		CORE		
CASING HAMMER		WEIGHT		DROP		BORING ANGLE AND DIRECTION <b>VERTICAL</b>		
SAMPLER <b>2/3 IN. O.D. SPLIT SPOON</b>						INSPECTOR <b>MARK HOULDAY</b>		
SAMPLER HAMMER		WEIGHT <b>140 LBS.</b>		DROP <b>30 IN.</b>				

DESCRIPTION	DEPTH, FT	NO.	RECOVER, FT	PENETR. BL/6 IN	TIME	HNU READINGS (PPM)			REMARKS
						SAMP. LE	AMBI. ENT AIR	TIME	
+ FILL, tan-orange-brown SAND with gravel, asphalt, and silt, moist	1	S-1	1.5'	7	305				Sampling began at 3:00. Raining - HNU not working!
+ FILL, brown silt with gravel, tr. clay and f. sand, moist	2	S-2	0.5'	5	325				Refusal at 2', moved bore-hole 5 times.
+ FILL, tan-brown m SAND with gravel and fiberglass, moist	3	S-3	0.8'	7	35				
+ FILL?, light brown m SAND with gravel, tr. silt, and wood, wet	4	S-4	0.8'	8	35				Sample interval 5-7' submitted for analysis
+ FILL?, tan-light brown m SAND with gravel, tr. silt, wet	5	S-5	1.3'	9	85				Hit water table at 7.5'
+ Dark brown SILT with organic matter (twigs), some f. sand, tr. clay, wet	6	S-6	1.3'	9	85				End drilling 5/18/88
+ Orange-tan m-c SAND, some gravel, tr. silt, wet	7	S-7	0.3'	3	85				Began sampling 5/19/88 8:00 AM
+ Orange m-c SAND, some gravel, wet	8	S-8	1.3'	4	85				
+ Orange m-c SAND, some gravel (12")	9	S-9	2.0'	4	85				
+ Grey clayey SILT, wet (12")	10	S-10	1.0'	5	85				

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MW-85

DESCRIPTION	PIEZOMETER	DEPTH, FT	SAMPLES				HNU READINGS (PPM)			REMARKS
			NO.	RECOV. FT	PENETR RESIST BL/SIN.	TIME	SAMPLE	AMBIENT AIR	TIME	
Grey clayey SILT, wet		21	S-11	1.5'	9 10 10 13	9:15				
Same as above		22	S-12	1.6'	5 6 4 5	9:20				
Same as above		23	S-13	1.9'	5 6 4 6	9:28				
Same as above		24	S-14	0.9'	5 4 5 5	9:35				
Grey f SAND with silt (~10")		25	S-15	1.6'	7 10 12 11	9:45				Hit a running sand at 28'. Washed borehole out!
Grey clayey SILT, wet (~10")		26								Boring terminated at 30'.
		27								
		28								
		29								
		30								

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LOG OF BORING..... MW-9S.....

SHEET 1 OF 2

PROJECT AND LOCATION <u>CIOA - GEIGY, Cranston, RI</u>		ELEVATION AND DATUM <u>15.44' MSL</u>		PROJECT NO <u>87X4660</u>	
DRILLING AGENCY <u>Soil Exploration</u>		FOREMAN <u>MARK</u>		DATE STARTED <u>5/20/88</u>	
DRILLING EQUIPMENT <u>TRUCK-MOUNTED DRILLING RIG</u>		COMPLETION DEPTH <u>34 FT</u>		ROCK DEPTH <u>NOT ENCOUNTERED</u>	
SIZE AND TYPE OF BIT <u>4 1/4" ID HSA</u>		SIZE AND TYPE CORE BARREL		NO. SAMPLES <u>17</u>	
CASING		DIST <u>17</u>		UNDIST	
CASING HAMMER		WATER LEVEL <u>5'</u>		COMPL	
WEIGHT		FIRET		CCPI	
DROP		INSPECTION ANGLE AND DIRECTION <u>VERTICAL</u>		IN HR	
SAMPLER <u>2-3 IN. O.D. SPLIT SPOONS</u>		INSPECTION		INSPECTION	
SAMPLER HAMMER		WEIGHT <u>140 LBS.</u>		DROP <u>30 IN.</u>	
		INSPECTION		<u>MARK HOWLDAY</u>	

DESCRIPTION	DEPTH, FT	NO.	RECOV. FT.	PENETRATION PRESSURE (BL/IN)	TIME	PNEUMATIC READINGS (PPM)				REMARKS
						SAMP LE	WATER	AIR	TIME	
+ FILL - black asphalt, tan to light brown of sand with gravel, tr. silt, moist.	1	S-1	1.5'	10 25 20 15	740	0.4	0.4	9.00		Sampling began at 7:35 5/20/88
+ FILL - brown to tan of sandy SILT with asphalt, gravel, moist	2	S-2	1.5'	19 20 53 27	750	0.8	0.4	9.00		* Samples S2-S3 composited for analysis.
+ FILL - brown to tan of sandy SILT with gravel and tr. clay, wet	3	S-3	1.2'	16 33 22 53	820	0.8	0.4	9.00		Hit water table at 5'
+ FILL - light brown to gray silty of sand with gravel, tr. clay, wet	4	S-4	0.8'	16 31 11 19	845	1.2	0.4	9.06		
+ Brown SILT with clay and gravel (6") Tan - light brown silty of SAND with gravel, wet (4")	5	S-5	0.8'	11 12 14 12	835	0.8	0.4	9.06		
+ Tan f-m SAND with gravel (4") Rust - orange clayey SILT (6") Gray clayey SILT (4"), wet	6	S-6	1.2'	6 7 6 6	845	0.8	0.4	10.00		
+ Gray clayey SILT, moist-wet	7	S-7	0.3'	9 9 9 9	850	0.7	0.4	10.00		
+ Same as above	8	S-8	1.3'	9 9 9 9	900	0.4	0.4	10.00		
+ Same as above	9	S-9	1.25'	9 9 9 9	905	0.5	0.4	10.06		
+ Same as above	10	S-10	1.4'	3 3 3 3	915	0.7	0.4	10.06		

MW-95

DESCRIPTION	PIEZOMETER	DEPTH, FT	SAMPLES				HNU READINGS (PPM)			REMARKS
			NO.	RECOV. FT	PENETR RESIST. BL/SIN.	TIME	SAMPLE	AMBIENT AIR	TIME	
Grey clayey SILT, wet		21	S-11	1.3'	1.3'	920	0.4	0.4	10'5	
Grey silty CLAY, wet		23	S-12	1.3'	2.2'	925	0.4	0.4	10'5	
Grey clayey SILT, wet		25	S-13	1.5'	10.9	935	0.4	0.4	10'5	
Same as above		27	S-14	1.7'	10.8	940	0.4	0.4	10'55	
Grey clayey SILT, wet (9")		29	S-15	1.3'	10.8	950	0.4	0.4	10'55	
Grey of sandy SILT, wet (6")		30			10.10					
Grey clayey SILT, wet		31	S-16	1.5'	3.3	958	0.4	0.4	10'55	
Grey clayey SILT, wet (9")		33	S-17	1.4'	3.3	10'10	0.4	0.4	10'55	Completed sampling at ~ 10 <sup>10</sup> AM 5/20/88.
Grey silty of SAND, wet (8")		34								Terminate boring at 34'

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LOG OF BORING P-10

SHEET 1 OF 3

PROJECT AND LOCATION <b>CIBA - GEIGY, RI</b>				ELEVATION AND DATUM <b>13.61' MSL</b>				PROJECT NO <b>87X4660</b>			
DRILLING AGENCY <b>Able Drilling</b>				FOREMAN <b>John Perry</b>				DATE STARTED <b>4/11/88</b>			
DRILLING EQUIPMENT <b>TRUCK-MOUNTED DRILLING RIG Mobil Drill (B40L)</b>				COMPLETION DEPTH <b>49.5' FT</b>				ROCK DEPTH <b>NOT ENCOUNTERED</b>			
SIZE AND TYPE OF BIT <b>2 1/4" Hollow Stem Auger</b>				SIZE AND TYPE CORE BARREL				NO. SAMPLES <b>23</b>		UNDIST.	
CASING				WATER LEVEL <b>5.5'</b>				COMPL.		24 HR.	
CASING HAMMER				WEIGHT				DROP			
SAMPLER <b>2 IN. O.D. SPLIT SPOON</b>				SAMPLING ANGLE AND DIRECTION <b>VERTICAL</b>				INSPECTOR <b>Mark Houlday</b>			
SAMPLER HAMMER				WEIGHT <b>140/320 LBS.</b>				DROP <b>30 IN.</b>			

DESCRIPTION	DEPTH, FT	SAMPLES				HNU READINGS (PPM)			REMARKS
		NO.	RECOV. FT.	PENETR. RESIST. BL/GIN	TIME	SAMP. LE	AMBI. AIR	TIME	
No Sample Taken	1								Sampling began ~ 9:30 AM.
FILL - brown to dark brown SILT with some clay, f sand, gravel, moist	2	S-1	0.5	16	9:30				Raining - HNU down
	3	S-2	0.3	6	9:35				Short spoon - 18"
Same as above	4	S-2	0.3	5	9:35				
No Sample Taken	5								
FILL - Black clayey SILT with some f sand, wet	6	S-3	0.5	5	9:40				Hit water table ~ 5.5'
	7	S-3	0.5	4	9:40				Greasy appearance, no odor.
FILL - Black greasy fiberglass, wood, some silt, wet	8	S-4	0.3	5	9:50				
	9	S-4	0.3	6	9:50				No obvious odor.
FILL - Black greasy fiberglass, wood, some silt, wet	10	S-5	0.3	4	10:05				
	11	S-5	0.3	2	10:05				
FILL - Black greasy fiberglass, wood, and silt (~ 20")	12	S-6	1.8	4	10:15				
Black - brown silty f sand with clay (~ 2")	13	S-6	1.8	3	10:15				FILL - Bina Sediment interface?
No Sample Taken	14								
Brown - grey silty f SAND with some clay and pit lenses, wet	15	S-7	0.9	2	10:25				Change in color of samples
	16	S-7	0.9	6	10:25				
No Sample Taken	17								
Grey silty f SAND with clay lenses, wet	18	S-8	0.6	11	10:33				
	19	S-8	0.6	8	10:33				
Grey - lt. black - brown silty f SAND with clay, wet	20	S-9	0.8	2	10:40				

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LOG OF BORING P1D

SHEET 2 OF 3

CASING PENETR. RESIST. BL/FT	DESCRIPTION	PIEZ.	DEPTH, FT	SAMPLES				GVA READINGS HNU (PPM)			REMARKS
				TYPE NUMBER	RECOV. FT	PENETR. RESIST. BL/IN.	time	SAMPLE	AMB. AIR	time	
	See previous page		20	S-9	0.8	2	10 <sup>40</sup>				
	Grey f SAND with silt, tr. clay, wet		21	S-10	1.8	5	10 <sup>53</sup>				
			22	S-10		7					
			23	S-10		6					
			24	S-11	1.1	2	10 <sup>59</sup>				
	Same as above		25	S-11		3					
			26	S-11		4					
			27	S-12	0.9	6	11 <sup>20</sup>				
	Same as above		28	S-12		4					
			29	S-12		3					
			30	S-13	0.6	3	11 <sup>30</sup>				
	Same as above		31	S-13		5					
			32	S-13		6					
			33	S-14	0.7	2	12 <sup>00</sup>				Approximate depth of fullbore
	Same as above		34	S-14		1					
			35	S-14		3					
			36	S-15	1.9	3	12 <sup>05</sup>				
	Same as above		37	S-15		5					
			38	S-15		4					
			39	S-16	0.8	4	12 <sup>25</sup>				
	Same as above		40	S-16		3					
			41	S-16		6					
			42	S-17	0.7	4	1 <sup>25</sup>				Stratigraphy very consistent
	Same as above		43	S-17		3					
			44	S-17		6					
			45	S-18	1.9	4	1 <sup>30</sup>				
	Same as above		46	S-18		4					
			47	S-18		6					
	Grey - brown - tan f SAND with silt and tr. clay, wet		48	S-19	2.0	11	1 <sup>45</sup>				Change in color of sedi- ments
			49	S-19		8					
			50	S-19		7					
	Same as above		51	S-20	2.0	6	2 <sup>30</sup>				
			52	S-20		4					
			53	S-20		3					
	Grey silty f SAND with tr. clay, wet		54	S-21	2.0	3	2 <sup>45</sup>				
			55	S-21		6					
			56	S-21		9					
	Same as above		57	S-22	1.1	11	2 <sup>50</sup>				
			58	S-22		12					





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LOG OF BORING.....*R14D*.....

SHEET 1 OF 3

PROJECT AND LOCATION <i>CIBA-GEIGY, RI</i>				ELEVATION AND DATUM <i>24.76' MSL</i>				PROJECT NO. <i>87X4660</i>							
DRILLING AGENCY <i>Able Drilling</i>				FOREMAN <i>John Perry</i>				DATE STARTED <i>4/14/88</i>				DATE FINISHED <i>4/15/88</i>			
DRILLING EQUIPMENT <b>TRUCK-MOUNTED DRILLING RIG</b> <i>Mobil Drill (B40L)</i>								COMPLETION DEPTH <i>58.5 FT</i>				ROCK DEPTH			
SIZE AND TYPE OF BIT <i>4" Hollow Stem Auger</i>				SIZE AND TYPE CORE BARREL				NO. SAMPLES		DIST <i>28</i>		UNDIST		CORE	
CASING				CASING HAMMER				WEIGHT		DROP		WATER LEVEL		FIRST <i>~ 8'</i>	
SAMPLER <b>2 IN. O.D. SPLIT SPOON</b>				SAMPLER HAMMER				WEIGHT <i>140 LBS.</i>		DROP <i>30 IN.</i>		BORING ANGLE AND DIRECTION <b>VERTICAL</b>			
												INSPECTOR <i>Mark Houlday</i>			

DESCRIPTION	FEET/METER	DEPTH, FT	SAMPLES				HNU READINGS (PPM)				REMARKS
			NO.	RECOV. FT.	PENETR. RESIST. BL/IN	TIME	SAMP. LE	AIR	ENT	TIME	
<i>Brown - dark brown clayey SILT with tr. of sand, gravel and organic debris, moist.</i>		1	S-1	1.2	3	1240					
					4						
					17						
<i>Brown - med clayey SILT with f-m sand and gravel, moist</i>		2	S-2	1.4	12	1244					
					16						
					16						
<i>Light brown - tan silty f SAND with gravel, moist.</i>		3	S-3	1.5	11	107					<i>HNU - background 0.4 - down borehole 0.4</i>
					11						
					21						
<i>Light brown - tan silty f SAND with gravel, moist</i>		4	S-4	1.3	20	112					
					18						
					16						
<i>Tan - Light brown f-m SAND, tr. gravel, wet</i>		5	S-5	1.1	4	130					<i>Hit water table at ~ 8'</i>
					5						
					5						
<i>Same as above</i>		6	S-6	1.4	3	135					
					6						
					7						
<i>Same as above</i>		7	S-7	1.3	3	145					
					6						
					7						
<i>Same as above</i>		8	S-8	1.3	10	150					
					10						
					10						
<i>Same as above</i>		9	S-9	1.4	6	215					
					9						
					8						
<i>No recovery</i>		10	S-10	N	5	229					<i>Wedged sampler in borehole</i>
					5						
					7						

**WOODWARD-CLYDE CONSULTANTS**  
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

LOG OF BORING P-14D

SHEET 2 OF 3

CASING PENETR. RESIST. BL/FT	DESCRIPTION	PIEZ.	DEPTH, FT	SAMPLES				OVA READINGS HNU (PPM)			REMARKS
				TYPE NUMBER	RECOVER, FT	PENETR. RESIST. BL/IN.	time	SAMPLE	AMB. AIR	time	
	Tan - light brown f SAND, tr. silt, wet (18") Rust m. SAND, wet (6")		20 21 22	S-11	2.0	9 12 15 18	4:45				Blews hydraulic hose on rig ~ 3:00 Rig fixed ~ 4:35
	Rust f-m SAND, tr. silt, wet		23 24	S-12	1.0	7 10 14 19	4:55				
	Same as above		25 26	S-13	2.0	4 5 8 20	5:10				Scanned samples and borehole with HNU - background only
	Rust f-m SAND, tr. silt and gravel, wet		27 28	S-14	2.0	17 24 25 37	5:30				
	No Sample Taken		29 30								
	Rust - brown f-m SAND, tr. silt, wet (~ 22") Brown clayey SILT, moist (~ 2").		31 32	S-15	2.0	24 26 30 39	5:55				Switched to 300 lb. hammer
	Rust - brown f-m SAND, tr. silt, wet		33 34	S-16	1.5	19 19 21 18	6:05				put down Casing - pulled up augers. Stopped sampling 7:30 4/14/88
	No Sample Taken		35								
	Grey clayey SILT with f sand, moist		36 37	S-17	1.0	6 8 10 15	10:15				Began sampling 4/15/88 10:15
	Grey clayey SILT with f SAND, moist		38 39	S-18	2.0	8 9 17 20	10:30				
	Grey - brown m SAND with gravel, tr. silt, clay, - wet		40 41	S-19	1.3	13 19 22 19	10:45				
	Brown - dark brown - rust - grey - f SAND with silt, clay, tr. gravel, wet		42 43	S-20	2.0	8 9 11 13	10:50				
	Grey clayey SILT, moist		44 45	S-21	1.3	4 5 6 11	11:15				
	No recovery			S-22	~ 2	5 7	11:30				

**WOODWARD-CLYDE CONSULTANTS**  
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

LOG OF BORING P-14D

SHEET 3 OF 3

CASING PENETR. RESIST. BL/FT	DESCRIPTION	PIEZ.	DEPTH, FT	SAMPLES				OVA READINGS (PPM)			REMARKS
				TYPE NUMBER	RECOV. FT	PENETR RESIST BL/6IN.	time	SAMPLE	AMB. AIR	time	
	No recovery		46	S-22	2	7	11:30				
			47	S-23	R	16					
	TILL - grey med sand, silt, clay and gravel, wet, poorly consolidated		48	S-23	1.1	6 8 12 12	12:00				
			49								
	TILL - grey m-c sand with gravel, tr. silt and clay, wet, poorly consolidated		50	S-24	1.0	9 11 19 20	12:10				
			51								
	Dark grey dense TILL (silty clay with rock fragments), moist		52	S-25	1.1	7 9 17 12	12:45				
			53								
	Dark grey dense TILL (silty clay with rock fragments), moist		54	S-26	0.8	21 27 35 39	1:00				
			55								
	Dark grey dense TILL (silty clay with tr. gravel, moist		56	S-27	0.6	38 32 37 35	1:05				
			57								
	Dark grey dense TILL (silty clay with tr. gravel, rock fragment in nose of spoon		58	S-28	0.3	32 39 46 62	1:10				Rock in spoon - grey, planar, with bulldging or foliation.
			59								
			60								

**PIEZOMETER AND MONITORING WELL  
CONSTRUCTION DETAILS**

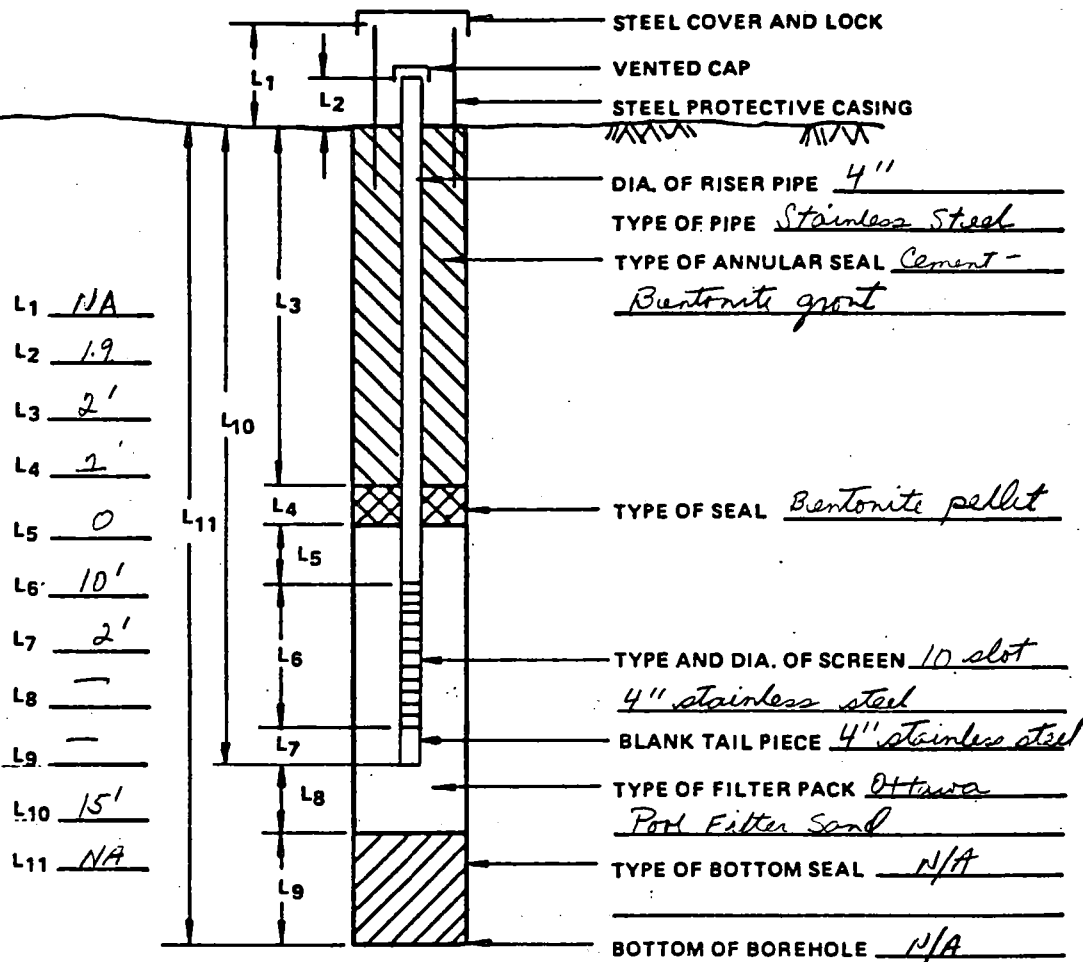
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AM89-149A

CONSTRUCTION OF MONITORING WELL NO. MW-15

PROJECT AND LOCATION <u>CIBA-GEIGY, Cranston, R.I.</u>	GROUND ELEV. AND DATUM <u>13.74' MSL</u>	PROJECT NO. <u>87x4660</u>
DRILLING AGENCY <u>Soil Exploration</u>	TOP OF RISER ELEV. <u>15.67'</u>	DATE FINISHED <u>5/18/88</u>
METHOD OF DRILLING <u>8 1/2" ID HSA</u>	TOP OF PROTECTIVE CASING ELEV. <u>NA</u>	INSPECTOR: <u>M. Houlday</u>
DIA. OF BOREHOLE <u>14"</u>	GROUND WATER ELEV. <u>10.46' (6/7/88)</u>	CHECKED BY:
DEPTH OF BOREHOLE <u>15'</u>		

GENERALIZED  
SOIL  
DESCRIPTION



NOT TO SCALE  
(VALUES REPORTED IN FT)

REMARKS Augered down to 15' using an 8 1/2" ID hollow stem auger. Installed blank tail piece (15'-13'), 10 slot screen (13'-3'), and riser pipe (3' ± 3' above ground surface). All well materials were constructed of 4" - sch. 5, 316 stainless steel. Well installation included a filter pack of Ottawa port sand (15'-4'), secondary filter pack (4'-3'), bentonite pellet seal (3'-2'), and a cement-bentonite annular seal (2'-surface). Cement Apron placed around steel casing.

### GENERALIZED SOIL DESCRIPTION



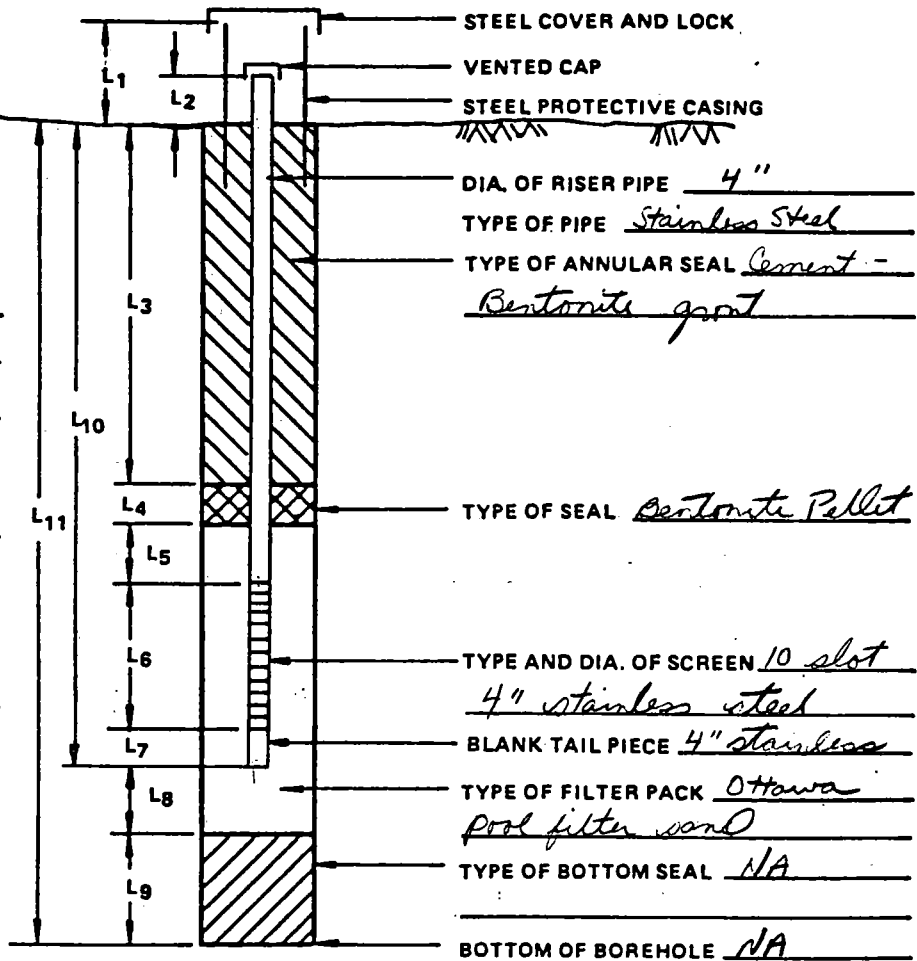
REMARKS Augered down to 50' using 8½" ID hollow stem augers. Installed blank tail piece (50-48'), 10 slot screen (48-38'), and riser pipe (38 - ~ 3' above ground surface). All well materials were constructed of 4", sch 5, 316 stainless steel. Well installation included a filter pack of Ottawa filter sand (50-36'); secondary filter pack (36-35'), bentonite pellet seal (35-30'), and a cement-bentonite annular seal (30'-surface). Cement apron placed around steel casing.

CONSTRUCTION OF MONITORING WELL NO. MW-25

PROJECT AND LOCATION <u>CIGA - GEIGY, Cranston, RI</u>	GROUND ELEV. AND DATUM <u>12.68' MSL</u>	PROJECT NO. <u>87x4660</u>
DRILLING AGENCY <u>Soil Exploration</u>	TOP OF RISER ELEV. <u>14.50'</u>	DATE FINISHED <u>5/17/88</u>
METHOD OF DRILLING <u>8 1/4" ID HSA</u>	TOP OF PROTECTIVE CASING ELEV. <u>NA</u>	INSPECTOR: <u>R. Henning</u>
DIA. OF BOREHOLE <u>14"</u>	GROUND WATER ELEV. <u>9.54' (6/7/88)</u>	CHECKED BY:
DEPTH OF BOREHOLE <u>20'</u>		

GENERALIZED  
SOIL  
DESCRIPTION

L1 NA  
 L2 1.8  
 L3 5'  
 L4 1'  
 L5 2  
 L6 10'  
 L7 2'  
 L8 —  
 L9 —  
 L10 20'  
 L11 NA



NOT TO SCALE  
(VALUES REPORTED IN FT)

REMARKS Augered down to 20' using an 8 1/4" ID hollow stem auger. Installed blank tail piece (20-18'); 10 slot screen (18-8') and riser (8 - ~ 3' above grade). All well materials were constructed of 4", sch. 5, 316 stainless steel. Well installation included a filter pack of Ottawa filter sand (20-7'), secondary filter pack (7-6'); bentonite pellet seal (6-5'), and a cement-bentonite annular seal (5-surface). Cement open placed around steel casing

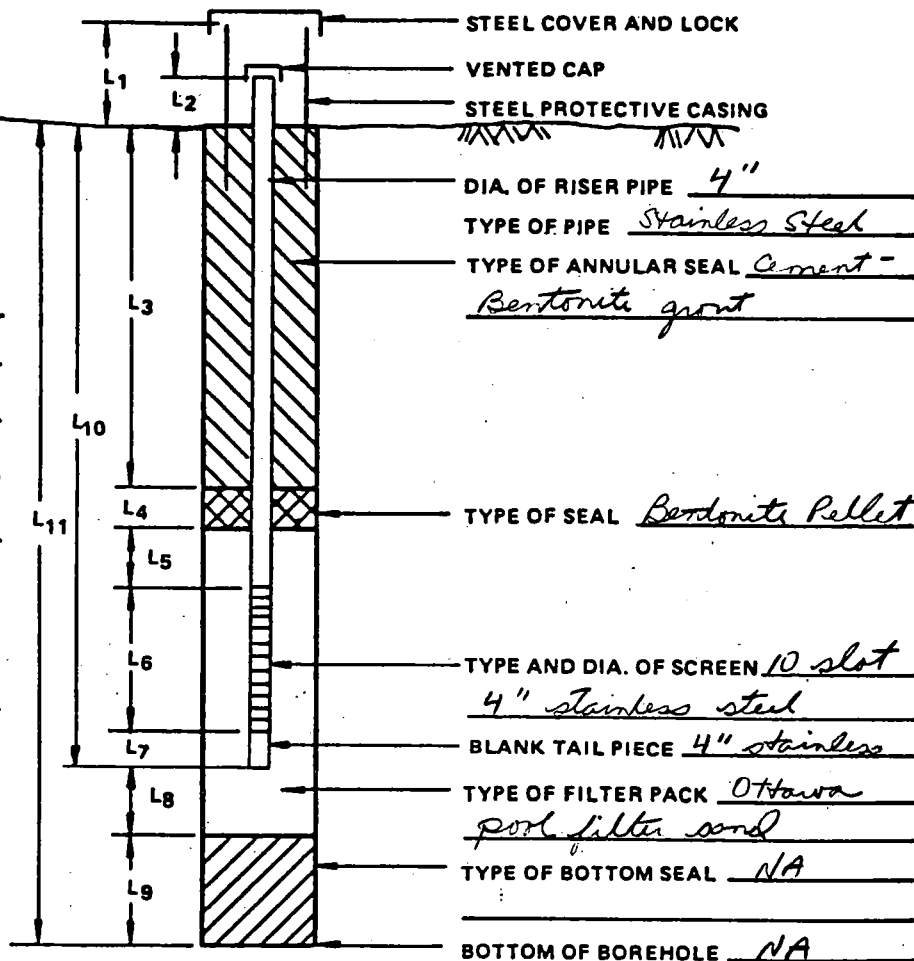


CONSTRUCTION OF MONITORING WELL NO. MW-35

PROJECT AND LOCATION <u>CIGA - GEIGY, Cranston, RI</u>	GROUND ELEV. AND DATUM <u>14.52' MSL</u>	PROJECT NO. <u>87X4660</u>
DRILLING AGENCY <u>Soil Exploration Corp.</u>	TOP OF RISER ELEV. <u>16.67'</u>	DATE FINISHED <u>5/17/88</u>
METHOD OF DRILLING <u>8 1/4" ID HSA</u>	TOP OF PROTECTIVE CASING ELEV. <u>NA</u>	INSPECTOR: <u>R.J. Henning</u>
DIA. OF BOREHOLE <u>14"</u>	GROUND WATER ELEV. <u>8.33 (6/7/88)</u>	CHECKED BY:
DEPTH OF BOREHOLE <u>20'</u>		

GENERALIZED  
SOIL  
DESCRIPTION

L1 NA  
 L2 2.2  
 L3 5'  
 L4 1'  
 L5 2'  
 L6 10'  
 L7 2'  
 L8 —  
 L9 —  
 L10 20'  
 L11 NA



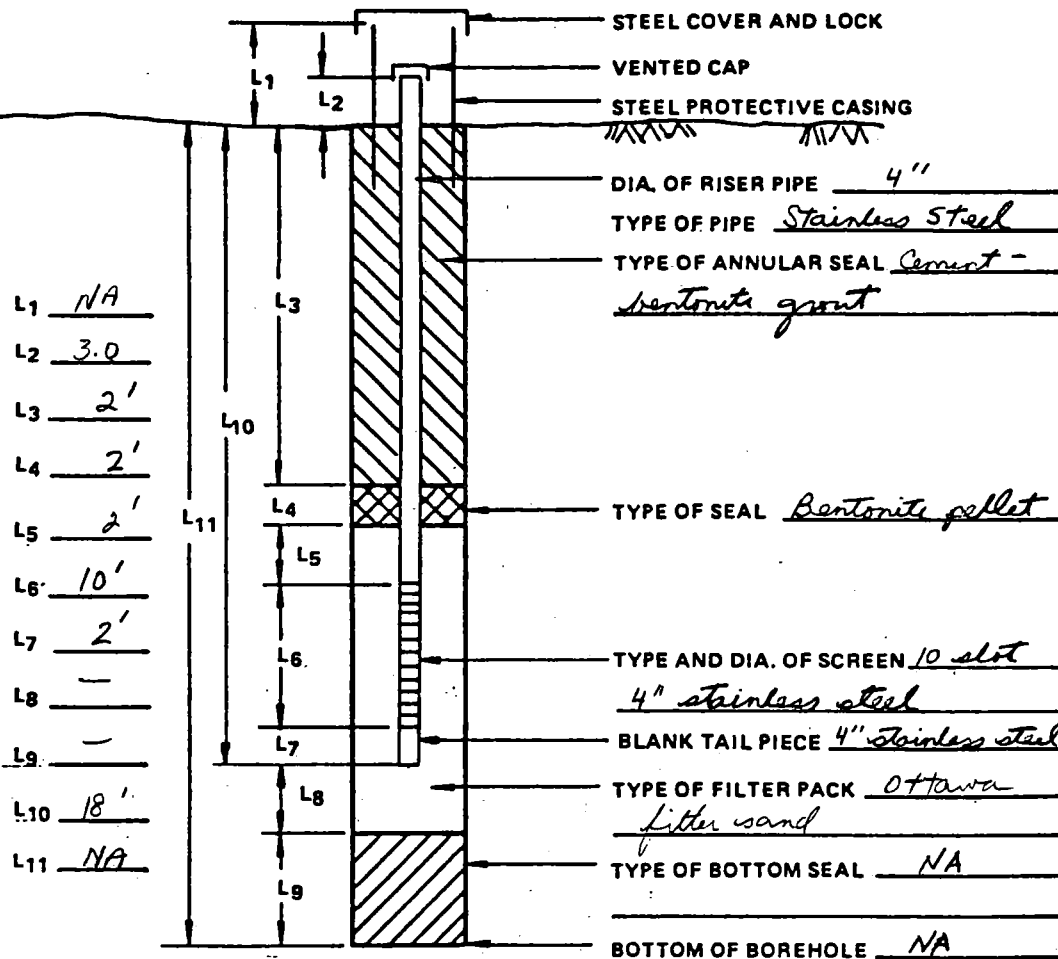
NOT TO SCALE  
(VALUES REPORTED IN FT)

REMARKS Augered down to 20' using an 8 1/4" ID hollow stem auger. Installed blank tail piece (20-18'); 10 slot screen (18-8') and riser (8-~2.5' above grade). All well materials were constructed of 4", sch. 5, 316 stainless steel. Well installer included a filter pack of Ottawa filter sand (20-7'), secondary filter pack (7-6'); bentonite pellet seal (6-5'), and a cement-bentonite annular seal. Cement grout placed around steel casing.

CONSTRUCTION OF MONITORING WELL NO. MW-45

PROJECT AND LOCATION <u>CIBA-GEIGY, Cranston, RI</u>	GROUND ELEV. AND DATUM <u>18.36' MSL</u>	PROJECT NO. <u>87-4660</u>
DRILLING AGENCY <u>Soil Exploration</u>	TOP OF RISER ELEV. <u>21.34'</u>	DATE FINISHED <u>5/17/88</u>
METHOD OF DRILLING <u>8 1/4" ID HSA</u>	TOP OF PROTECTIVE CASING ELEV. <u>NA</u>	INSPECTOR: <u>MARK HOULDAY</u>
DIA. OF BOREHOLE <u>14"</u>	GROUND WATER ELEV. <u>12.11 (6/7/88)</u>	CHECKED BY:
DEPTH OF BOREHOLE <u>18'</u>		

GENERALIZED  
SOIL  
DESCRIPTION



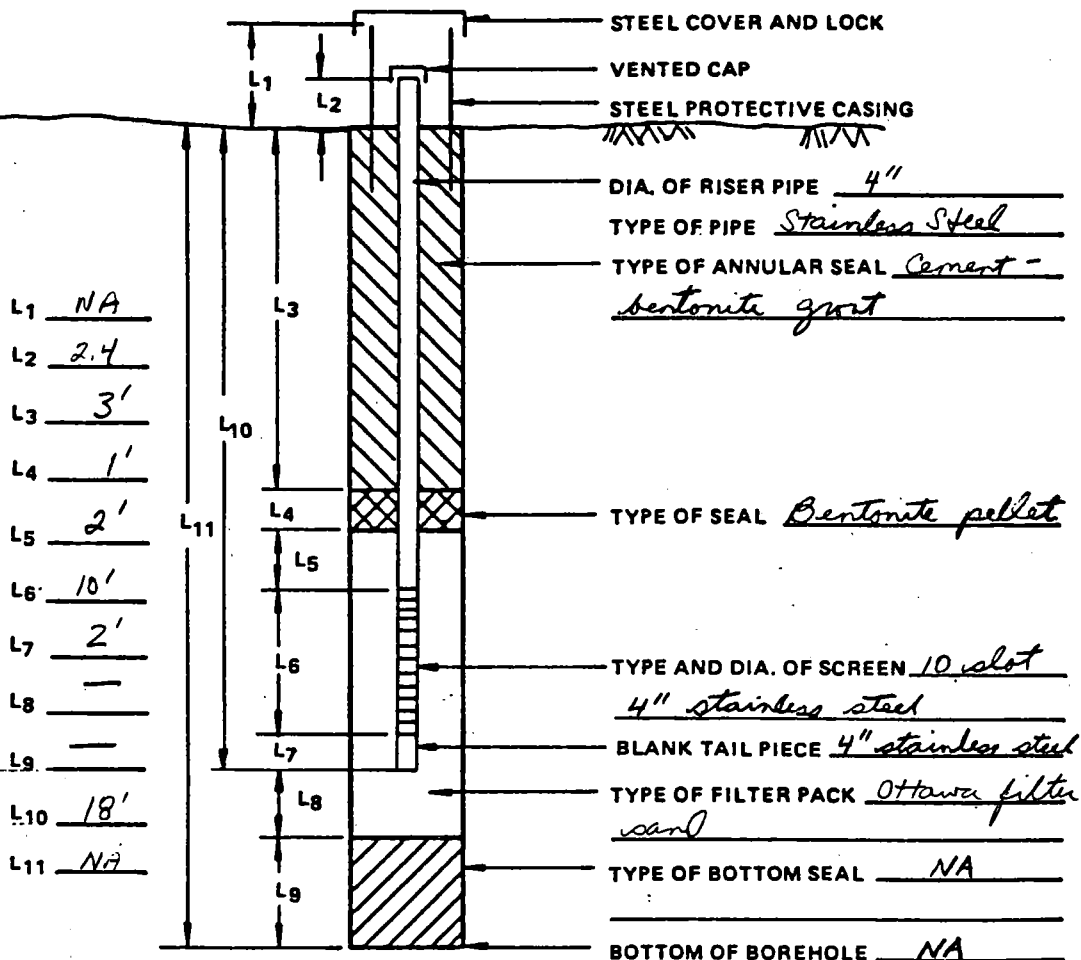
NOT TO SCALE  
(VALUES REPORTED IN FT)

REMARKS Augered down to 18' using 8 1/4" ID hollow stem augers. Installed blank tail piece (18'-16'), 10 slot screen (16'-6'), and riser pipe (6'-~3' above surface). All well materials were constructed of 4", sch. 5, 316 stainless steel. Well installation included a filter pack of Ottawa filter sand (18'-5'), secondary filter pack (5'-4'), bentonite pellet seal (4'-2'), and a cement-bentonite annular seal (2'-surface). Cement grout placed around steel casing.

CONSTRUCTION OF MONITORING WELL NO. MW-55

PROJECT AND LOCATION <u>CIBA-GEIGY, Cranston, RI</u>	GROUND ELEV. AND DATUM <u>23.82' MSL</u>	PROJECT NO. <u>87x4660</u>
DRILLING AGENCY <u>Soil Exploration</u>	TOP OF RISER ELEV. <u>26.23'</u>	DATE FINISHED <u>5/23/88</u>
METHOD OF DRILLING <u>8 1/2" ID HSA</u>	TOP OF PROTECTIVE CASING ELEV. <u>NA</u>	INSPECTOR: <u>M. HOULDAY</u>
DIA. OF BOREHOLE <u>14"</u>	GROUND WATER ELEV. <u>12.11 (6/7/88)</u>	CHECKED BY:
DEPTH OF BOREHOLE <u>18'</u>		

GENERALIZED  
SOIL  
DESCRIPTION



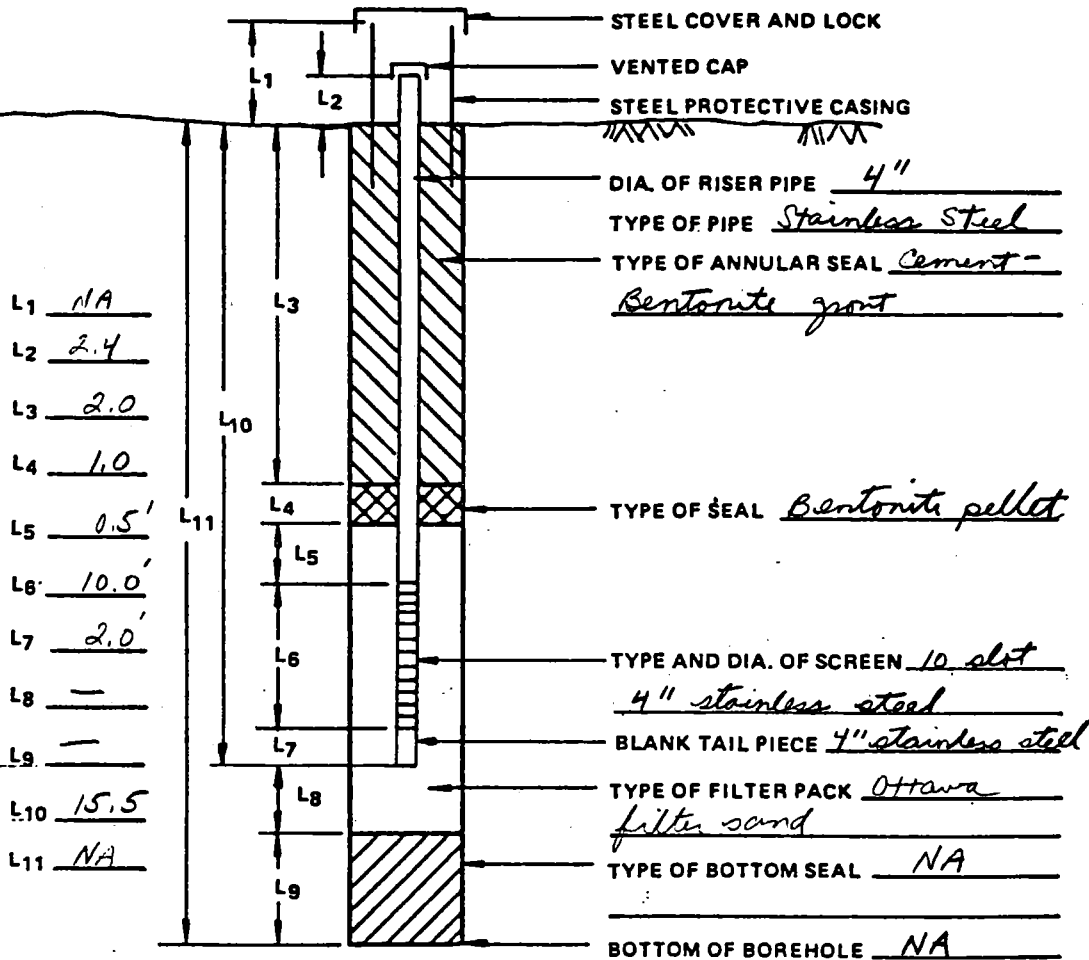
NOT TO SCALE  
(VALUES REPORTED IN FT)

REMARKS Augered down to 18' using 8 1/2" hollow stem augers. Installed blank tail piece (18-16'), 10 slot screen (16-6'), and riser pipe (6'-~3' above ground surface). All well materials were constructed of 4", sch. 5, 316 stainless steel. Well installation included a filter pack of Ottawa filter sand (18-5'), secondary filter pack (5-4'), bentonite pellet seal (4-3'), and a cement-bentonite annular seal (3'-surface). Cement grout placed around steel casing

CONSTRUCTION OF MONITORING WELL NO. MW-65

PROJECT AND LOCATION <u>CIBA-GEIGY, Cranston, RI</u>		GROUND ELEV. AND DATUM <u>11.62' MSL</u>	PROJECT NO. <u>87X4660</u>
DRILLING AGENCY <u>Soil Exploration</u>		TOP OF RISER ELEV. <u>14.04'</u>	DATE FINISHED <u>5/19/88</u>
METHOD OF DRILLING <u>8 1/4" ID HSA</u>		TOP OF PROTECTIVE CASING ELEV. <u>NA</u>	INSPECTOR: <u>M. HOULDAY</u>
DIA. OF BOREHOLE <u>14"</u>		GROUND WATER ELEV. <u>7.17 (6/7/88)</u>	CHECKED BY:
DEPTH OF BOREHOLE <u>15.5'</u>			

GENERALIZED  
SOIL  
DESCRIPTION

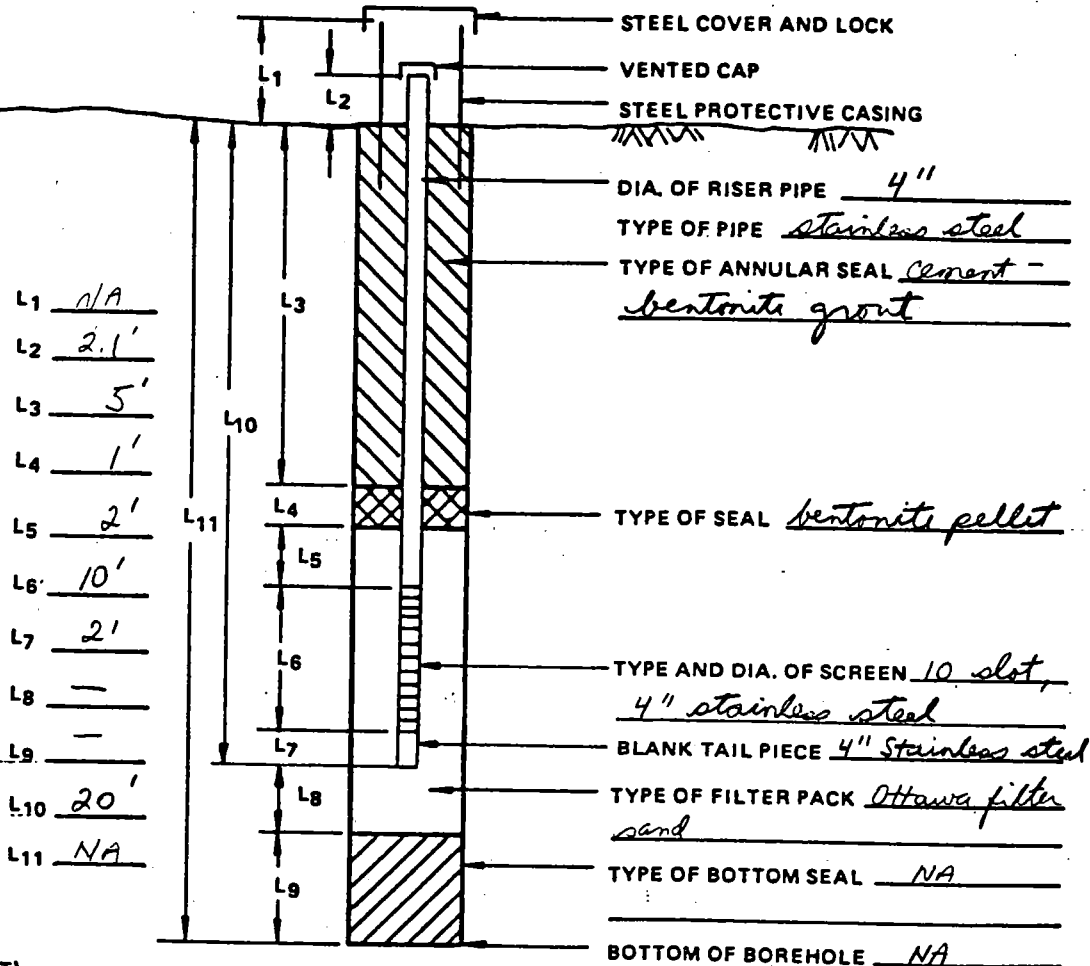


NOT TO SCALE  
(VALUES REPORTED IN FT)

REMARKS Augered down to 15.5' using using 8 1/4" ID hollow stem augers. Installed blank tail piece (15.5-13.5'), 10 slot screen (13.5-3.5'), and riser pipe (3.5-~3' above ground surface). All well materials were constructed of 4", sch.5, 316 stainless steel. Well installation included a filter pack of Ottawa filter sand (15.5-3'), bentonite pellet seal (3'-2'), and a cement-bentonite annular seal (2'-surface). Cement upon placed around steel casing

CONSTRUCTION OF MONITORING WELL NO. MW-75

PROJECT AND LOCATION <u>CIBA-GEIGY, Cranston, RI</u>	GROUND ELEV. AND DATUM <u>13.04' MSL</u>	PROJECT NO. <u>87X4660</u>
DRILLING AGENCY <u>Soil Exploration</u>	TOP OF RISER ELEV. <u>15.18'</u>	DATE FINISHED <u>5/18/88</u>
METHOD OF DRILLING <u>8 1/4" ID HSA</u>	TOP OF PROTECTIVE CASING ELEV. <u>NA</u>	INSPECTOR: <u>M. HOULDAY</u>
DIA. OF BOREHOLE <u>14"</u>	GROUND WATER ELEV. <u>8.13' (6/7/88)</u>	CHECKED BY:
DEPTH OF BOREHOLE <u>20'</u>		

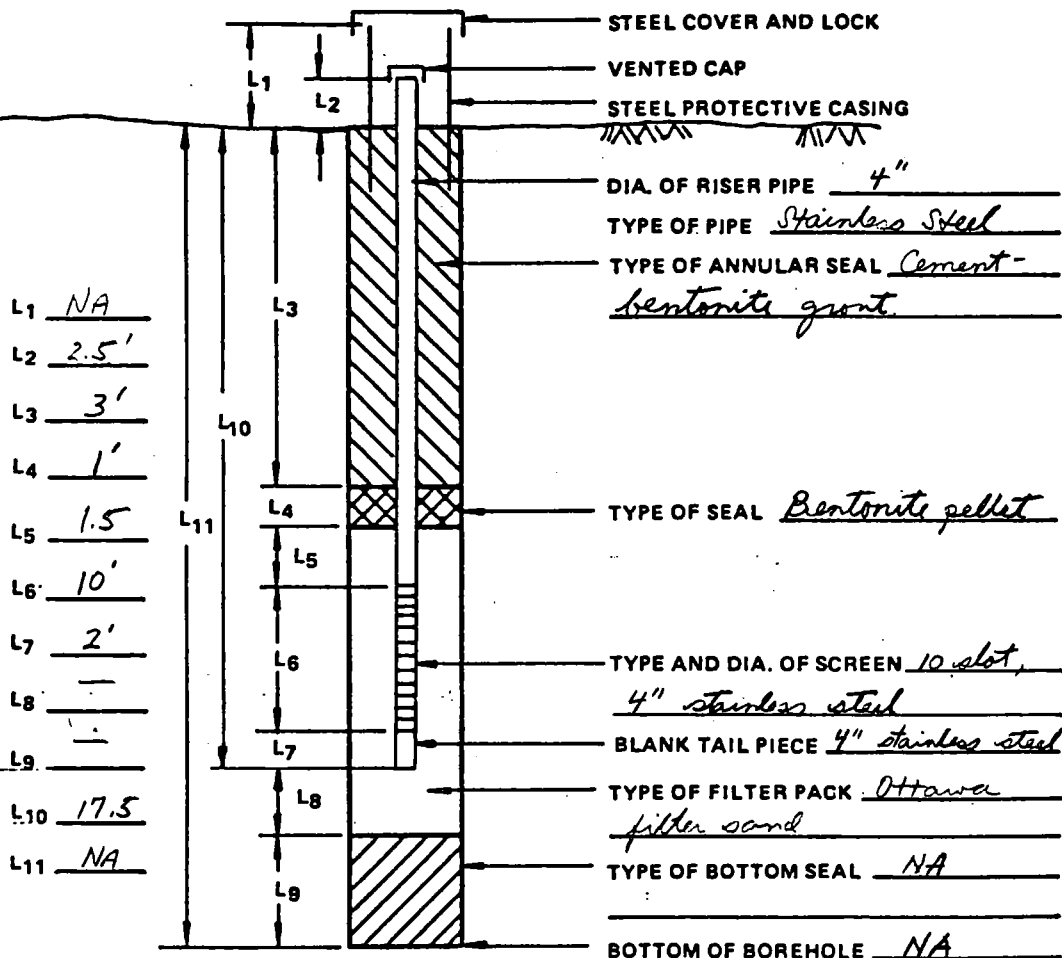
GENERALIZED  
SOIL  
DESCRIPTION

NOT TO SCALE  
(VALUES REPORTED IN FT)

REMARKS Augered down to 20' using 8 1/4" ID hollow stem augers.  
Installed blank tail piece (20-18'); 10 slot screen (18-8'); and  
riser pipe (8-~2' above ground surface). All well materials  
were constructed of 4", sch. 5, 316 stainless steel. Well installation  
included a filter pack of Ottawa filter sand (20-7'), secondary filter pack  
(7-6'), bentonite pellet seal (6-5'), and a cement - bentonite  
annular seal (5-surface). Cement grout placed around steel  
casing

CONSTRUCTION OF MONITORING WELL NO. MW-85

PROJECT AND LOCATION <u>CIBA-GEIGY, Cranston, RI</u>	GROUND ELEV. AND DATUM <u>15.00' MSL</u>	PROJECT NO. <u>87x4660</u>
DRILLING AGENCY <u>Soil Exploration</u>	TOP OF RISER ELEV. <u>17.53'</u>	DATE FINISHED <u>5/19/88</u>
METHOD OF DRILLING <u>8 1/4" ID HSA</u>	TOP OF PROTECTIVE CASING ELEV. <u>NA</u>	INSPECTOR: <u>M. HOULDAY</u>
DIA. OF BOREHOLE <u>14"</u>	GROUND WATER ELEV. <u>6.29' (6/17/88)</u>	CHECKED BY:
DEPTH OF BOREHOLE <u>17.5'</u>		

GENERALIZED  
SOIL  
DESCRIPTION

NOT TO SCALE  
(VALUES REPORTED IN FT)

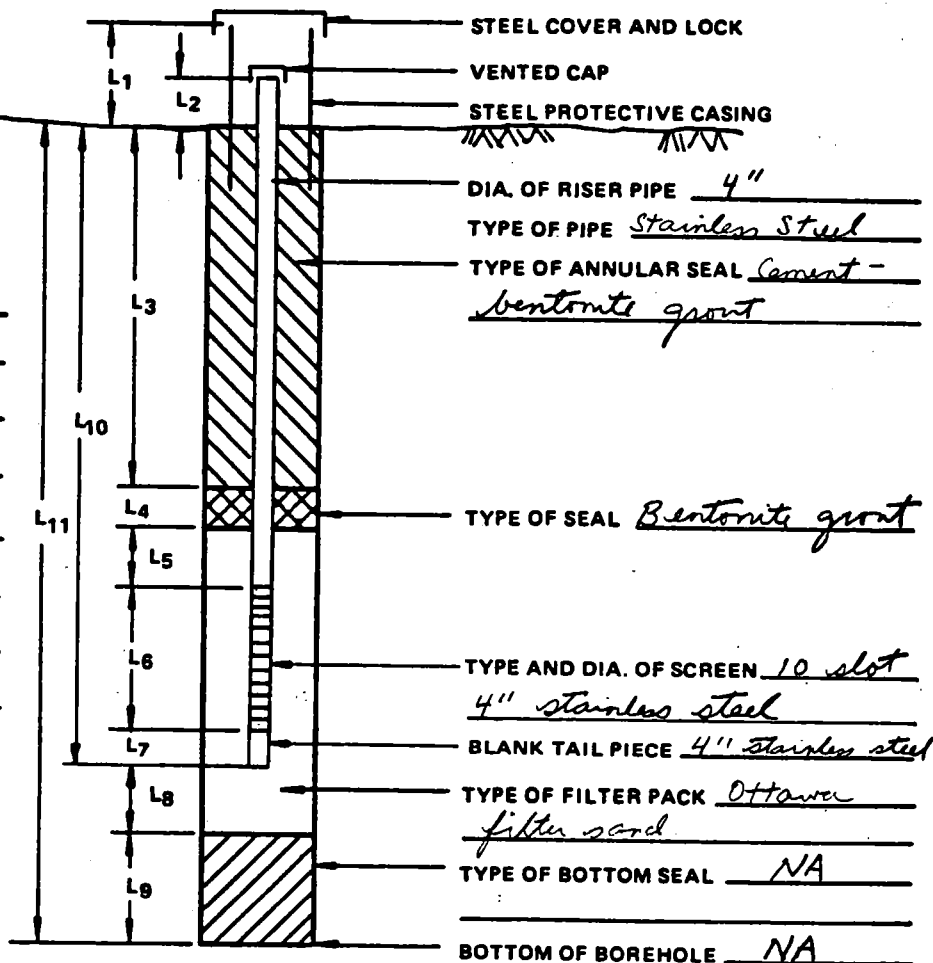
REMARKS Augered down to 17.5' using 8 1/4" ID hollow stem augers.  
Installed blank tail piece (17.5 - 15.5'); 10 slot screen (15.5 - 5.5'), and  
riser pipe (5.5 - ~3' above ground surface). All well materials were  
constructed of 4", sch 5, 316 stainless steel. Well installation included  
a filter pack of Ottawa filter sand (17.5' - 5'); secondary filter pack (5 - 4'),  
bentonite pellet seal (4 - 3'), and a cement-bentonite annular seal  
(3' - surface). Cement apron placed around steel casing

CONSTRUCTION OF MONITORING WELL NO. MW-95

PROJECT AND LOCATION <u>CIBA-GEIGY, Cranston, RI</u>		GROUND ELEV. AND DATUM <u>15.41' MSL</u>	PROJECT NO. <u>87X4660</u>
DRILLING AGENCY <u>Soil Exploration</u>		TOP OF RISER ELEV. <u>17.84'</u>	DATE FINISHED <u>5/20/88</u>
METHOD OF DRILLING <u>8 1/4" ID HSA</u>		TOP OF PROTECTIVE CASING ELEV. <u>NA</u>	INSPECTOR: <u>M. HOULDAY</u>
DIA. OF BOREHOLE <u>14"</u>		GROUND WATER ELEV. <u>11.60' (6/7/88)</u>	CHECKED BY:
DEPTH OF BOREHOLE <u>15'</u>			

GENERALIZED  
SOIL  
DESCRIPTION

L1 NA  
 L2 2.4  
 L3 2'  
 L4 1'  
 L5 0  
 L6 10'  
 L7 2'  
 L8 —  
 L9 —  
 L10 15'  
 L11 NA



NOT TO SCALE  
(VALUES REPORTED IN FT)

REMARKS Augered down to 15' using 8 1/4" ID hollow stem augers. Installed blank tail piece (15'-13'), 10 slot screen (13'-3'), and riser pipe (3'-~3' above ground surface). All well materials were constructed of 4", sch. 5, 316 stainless steel. Well installation included a filter pack of Ottawa filter sand (15'-4'), secondary filter pack (4'-3'), bentonite pellet seal (3'-2'), and a cement-bentonite annular seal (2'-surface). Cement apron placed around steel casing



# PIEZOMETER INSTALLATION REPORT

Project CIBA - GEIGY

Piezometer No. P-15

Project No. 87X 4660

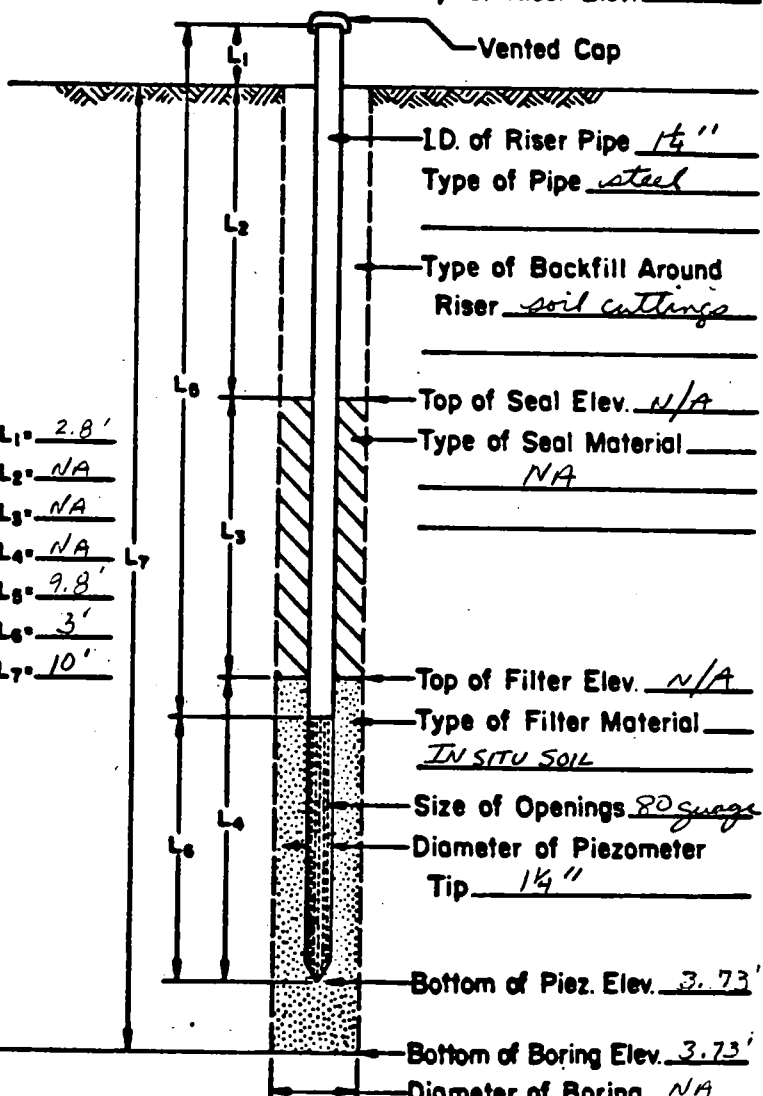
Location Production Area (Sitten End)

Installed By Able Drilling

Date 4/11/88 Time 3:30

Method of Installation Augered through ~ 2' of fill materials. Inserted well point and drove well point down to a depth of 10'.

## LOG OF BORING AND PIEZOMETER

BORING			PIEZOMETER	
Depth in ft.	Description	Symbol	Type of Piezometer <u>3' galvanized steel well point</u>	
			Ground Elev. <u>13.73'</u>	Top of Riser Elev. <u>16.48'</u>
0	FILL, brown - dark brown silt with some clay, of sand, and gravel, moist.		 <p style="text-align: right;">Vented Cap</p> <p>— ID. of Riser Pipe <u>1 1/4"</u></p> <p>— Type of Pipe <u>steel</u></p> <p>— Type of Backfill Around Riser <u>soil cuttings</u></p> <p>— Top of Seal Elev. <u>N/A</u></p> <p>— Type of Seal Material <u>NA</u></p> <p>— Top of Filter Elev. <u>N/A</u></p> <p>— Type of Filter Material <u>IN SITU SOIL</u></p> <p>— Size of Openings <u>80 gauge</u></p> <p>— Diameter of Piezometer Tip <u>1 1/4"</u></p> <p>— Bottom of Piez. Elev. <u>3.73'</u></p> <p>— Bottom of Boring Elev. <u>3.73'</u></p> <p>— Diameter of Boring <u>NA</u></p>	
5	(Observations based on return of soil cuttings during drilling)			
			<p>L<sub>1</sub> = <u>2.8'</u></p> <p>L<sub>2</sub> = <u>NA</u></p> <p>L<sub>3</sub> = <u>NA</u></p> <p>L<sub>4</sub> = <u>NA</u></p> <p>L<sub>5</sub> = <u>9.8'</u></p> <p>L<sub>6</sub> = <u>3'</u></p> <p>L<sub>7</sub> = <u>10'</u></p>	

Remarks Cement apron placed around riser

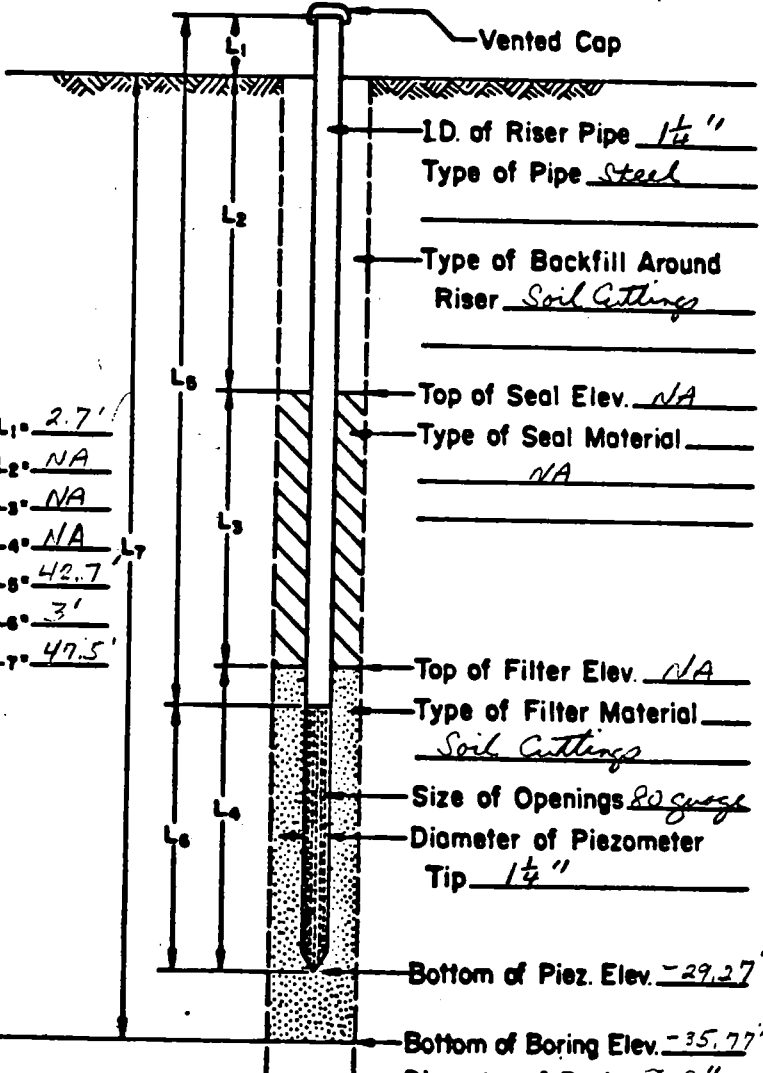
Inspected By M. H. H. H.

WOODWARD - CLYDE CONSULTANTS

# PIEZOMETER INSTALLATION REPORT

Project CIBA-GEIGY Piezometer No. P1D  
 Project No. 87x4660 Installed By Able Drilling Location Production Area (Southern End)  
 Date 4/11/88 Time 3:00  
 Method of Installation Using a 4" ID hollow stem auger, drilled down to ~ 47.5'  
Installed well point to 43'. Backfilled using soil cuttings.

## LOG OF BORING AND PIEZOMETER

BORING			PIEZOMETER	
Depth in ft.	Description	Symbol	Type of Piezometer <u>3' galvanized steel well point</u>	
	<i>See Boring Logs for P1D</i>		Ground Elev. <u>13.73</u>	Top of Riser Elev. <u>16.38'</u>
				
			Vented Cap I.D. of Riser Pipe <u>1 1/4"</u> Type of Pipe <u>Steel</u> Type of Backfill Around Riser <u>Soil Cuttings</u> Top of Seal Elev. <u>NA</u> Type of Seal Material <u>NA</u> Top of Filter Elev. <u>NA</u> Type of Filter Material <u>Soil Cuttings</u> Size of Openings <u>80 gauge</u> Diameter of Piezometer Tip <u>1 1/4"</u> Bottom of Piez. Elev. <u>-29.27'</u> Bottom of Boring Elev. <u>-35.77'</u> Diameter of Boring <u>~ 8"</u>	
			L1 <u>2.7'</u> L2 <u>NA</u> L3 <u>NA</u> L4 <u>NA</u> L5 <u>42.7</u> L6 <u>3'</u> L7 <u>47.5'</u>	

Remarks Took continuous split spoon samples down to ~ 49.5'. Hit clay layer at about 47.5'. Sediments washed up into auger. As a result, we could only get piezometer down to a depth of 43'. Cement apron placed around riser

Inspected By Mark Hordley  
 WOODWARD - CLYDE CONSULTANTS

# PIEZOMETER INSTALLATION REPORT

Project CIBA - GEIGY Piezometer No. P-25  
 Project No. 87X4662 Location Production Area (Southern End)  
 Installed By Able Drilling Date 4/12/88 Time 8:32 AM  
 Method of Installation Augered down through fill material ( $\approx 4.5'$ ). Pushed well point down to a depth of 8-11'.

## LOG OF BORING AND PIEZOMETER

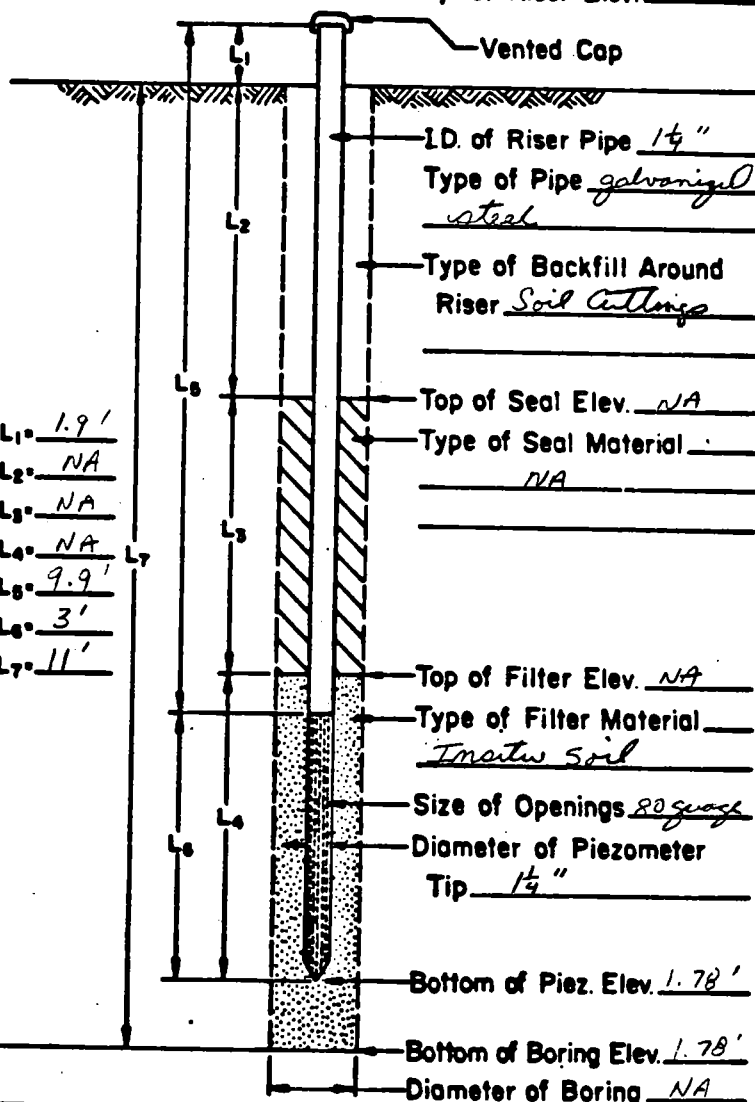
### BORING

Depth in ft.	Description	Symbol
0	FILL - brown - dark brown silt with sand, clay and gravel, moist. (Observations based on return of soil cuttings during drilling)	
5		
10		
15		
20		

### PIEZOMETER

Type of Piezometer 3' galvanized steel well point

Ground Elev. 12.78' Top of Riser Elev. 14.71'



Remarks Encountered alot of fill material during installation. Location of piezometer was moved 3 times before installation could be completed. Cement apron was placed around riser

Inspected By Mark Houlden  
 WOODWARD - CLYDE CONSULTANTS

# PIEZOMETER INSTALLATION REPORT

Project CIBA-GEIGY

Piezometer No. P-35

Project No. 87X4660

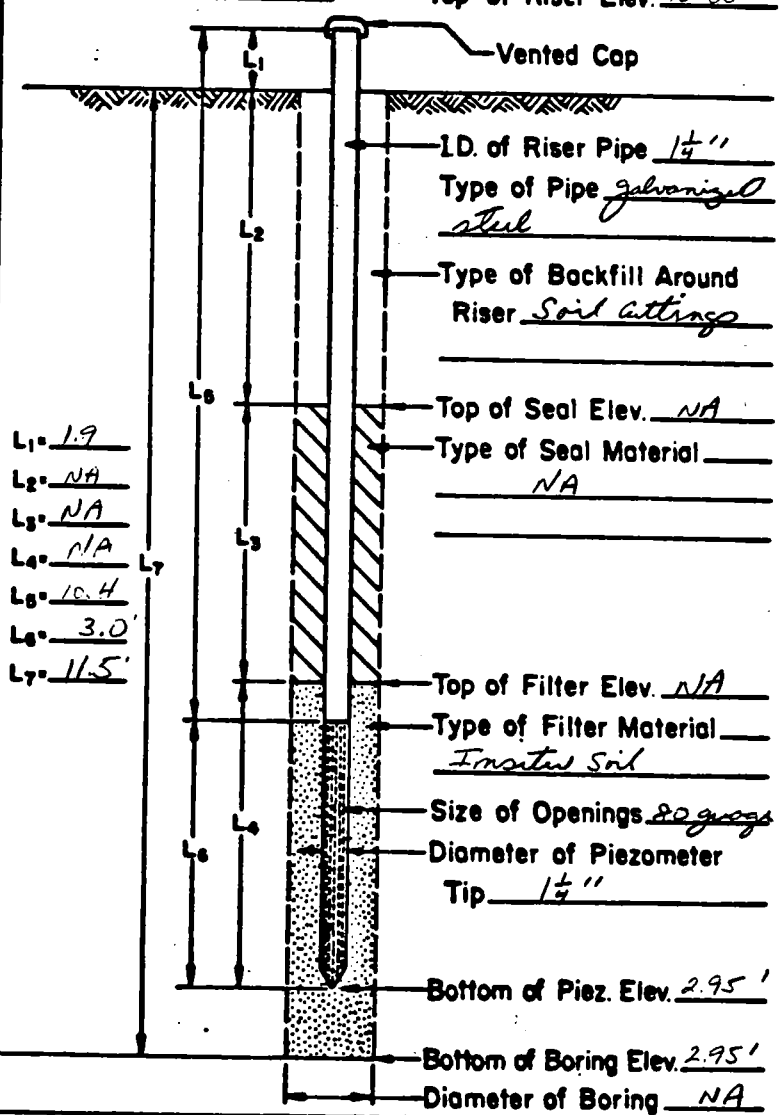
Installed By Able Drilling

Location Production Area (Southern End)

Date 4/12/88 Time ~ 9:30

Method of Installation Augered through fill material down to a depth of 3'.  
Pushed and rammed well point down to 8.5 - 11.5'.

## LOG OF BORING AND PIEZOMETER

BORING			PIEZOMETER	
Depth in ft.	Description	Symbol	Type of Piezometer	
			<u>3' galvanized steel well point</u>	
			Ground Elev. <u>14.45'</u>	Top of Riser Elev. <u>16.33'</u>
0	FILL - brown-dark brown silt with f sand, clay and gravel, moist. (Observation based on return of soil cuttings during drilling).		 <p>Vented Cap</p> <p>I.D. of Riser Pipe <u>1 1/4"</u></p> <p>Type of Pipe <u>galvanized steel</u></p> <p>Type of Backfill Around Riser <u>Soil Cuttings</u></p> <p>Top of Seal Elev. <u>NA</u></p> <p>Type of Seal Material <u>NA</u></p> <p>Top of Filter Elev. <u>NA</u></p> <p>Type of Filter Material <u>Insitu Soil</u></p> <p>Size of Openings <u>20 gage</u></p> <p>Diameter of Piezometer Tip <u>1 1/4"</u></p> <p>Bottom of Piez. Elev. <u>2.95'</u></p> <p>Bottom of Boring Elev. <u>2.95'</u></p> <p>Diameter of Boring <u>NA</u></p>	
5				
			L <sub>1</sub> <u>1.9</u>	
			L <sub>2</sub> <u>NA</u>	
			L <sub>3</sub> <u>NA</u>	
			L <sub>4</sub> <u>NA</u>	
			L <sub>5</sub> <u>10.4</u>	
			L <sub>6</sub> <u>3.0</u>	
			L <sub>7</sub> <u>11.5</u>	

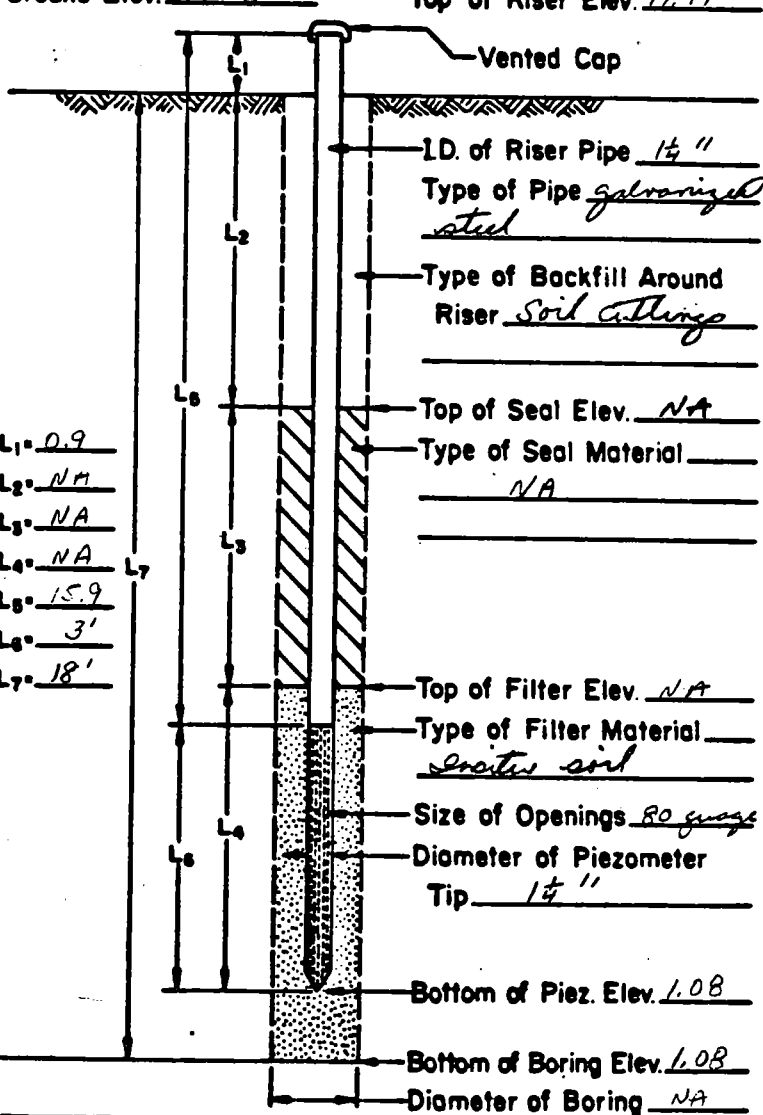
Remarks Cement apron placed around riser

Inspected By Mr. Houlden

# PIEZOMETER INSTALLATION REPORT

Project CIBA - GEIGY Piezometer No. P-45  
 Project No. 87X4660 Installed By Atkins Drilling Location Production Area (along Hill St.)  
 Date 4/12/88 Time 10<sup>00</sup> AM  
 Method of Installation Augered down through 2' of fill material. Pushed down piezometer to 15-18'.

## LOG OF BORING AND PIEZOMETER

BORING			PIEZOMETER	
Depth in ft.	Description	Symbol	Type of Piezometer	
			Ground Elev. <u>19.08'</u>	Top of Riser Elev. <u>19.99'</u>
0	FILL - brown sandy silt with some clay and gravel, moist. (Observations based on return of soil cuttings during drilling).			
5			Vented Cap ID. of Riser Pipe <u>1 1/2"</u> Type of Pipe <u>galvanized steel</u> Type of Backfill Around Riser <u>Soil Cuttings</u>	
			Top of Seal Elev. <u>NA</u> Type of Seal Material <u>NA</u>	
			Top of Filter Elev. <u>NA</u> Type of Filter Material <u>gravel soil</u> Size of Openings <u>80 gauge</u> Diameter of Piezometer Tip <u>1 1/2"</u>	
			Bottom of Piez. Elev. <u>1.08</u> Bottom of Boring Elev. <u>1.08</u> Diameter of Boring <u>NA</u>	
			L <sub>1</sub> = <u>0.9</u> L <sub>2</sub> = <u>NA</u> L <sub>3</sub> = <u>NA</u> L <sub>4</sub> = <u>NA</u> L <sub>5</sub> = <u>15.9</u> L <sub>6</sub> = <u>3'</u> L <sub>7</sub> = <u>18'</u>	

Remarks Used elevation of existing piezometer (GW4) to target installation depth of P4. Depth of water in GW4 = 12.9'. Well point was therefore installed at 15-18'. Cement apron placed around riser.

Inspected By

*PA Houlden*

WOODWARD - CLYDE CONSULTANTS

# PIEZOMETER INSTALLATION REPORT

Project CIBA - FE16Y Piezometer No. P55  
 Project No. 87X4660 Installed By ALL Drilling Location Production Area (South-Central Area)  
 Date 4/12/88 Time 10:30  
 Method of Installation Augured down to 2'. Inserted well point, pushed and drove piezometer down to 13-16'.

## LOG OF BORING AND PIEZOMETER

BORING			PIEZOMETER	
Depth in ft.	Description	Symbol	Type of Piezometer	
			<u>3' galvanized steel well point</u>	
			Ground Elev. <u>18.48'</u>	Top of Riser Elev. <u>21.27'</u>
			Vented Cap ID. of Riser Pipe <u>1 1/2"</u> Type of Pipe <u>galvanized steel</u> Type of Backfill Around Riser <u>soil cuttings</u> Top of Seal Elev. <u>NA</u> Type of Seal Material <u>NA</u> Top of Filter Elev. <u>NA</u> Type of Filter Material <u>Insitu soil</u> Size of Openings <u>80 gauge</u> Diameter of Piezometer Tip <u>1 1/4"</u> Bottom of Piez. Elev. <u>2.48'</u> Bottom of Boring Elev. <u>2.48'</u> Diameter of Boring <u>NA</u>	
			L <sub>1</sub> = <u>2.8'</u> L <sub>2</sub> = <u>NA</u> L <sub>3</sub> = <u>NA</u> L <sub>4</sub> = <u>NA</u> L <sub>5</sub> = <u>15.8'</u> L <sub>6</sub> = <u>3'</u> L <sub>7</sub> = <u>16'</u>	

Remarks Assumed depth of water table to be  $\approx$  11' (based on depth of water in GW4). Cement apron placed around riser

Inspected By

Ph. Hordley

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# PIEZOMETER INSTALLATION REPORT

Project CIBA - GEIGY Piezometer No. P6S  
 Project No. 87X4660 Installed By Atk. Drilling Location Production Area (Near RR Tracks)  
 Date 4/12/88 Time 1200  
 Method of Installation Augured down to 2'; inserted well point, pushed and  
hammered piezometer down to 15'-18'.

## LOG OF BORING AND PIEZOMETER

BORING			PIEZOMETER	
Depth in ft.	Description	Symbol	Type of Piezometer	
			Ground Elev. <u>21.61'</u>	Top of Riser Elev. <u>23.71'</u>
0	FILL - Brown - dark brown silty of sand with some clay, moist.		<p>             Vented Cap              ID. of Riser Pipe <u>1 1/4"</u>              Type of Pipe <u>galvanized</u>              Type of Backfill Around Riser <u>Soil Cuttings</u>              Top of Seal Elev. <u>NA</u>              Type of Seal Material <u>NA</u>              Top of Filter Elev. <u>NA</u>              Type of Filter Material <u>Drifter Soil</u>              Size of Openings <u>80 gauge</u>              Diameter of Piezometer Tip <u>1 1/4"</u>              Bottom of Piez. Elev. <u>3.61</u>              Bottom of Boring Elev. <u>3.61</u>              Diameter of Boring <u>NA</u> </p>	
5	(Observations based on return of soil cuttings during drilling)			
			L <sub>1</sub> <u>3.9'</u> L <sub>2</sub> <u>NA</u> L <sub>3</sub> <u>NA</u> L <sub>4</sub> <u>NA</u> L <sub>5</sub> <u>18.9'</u> L <sub>6</sub> <u>3</u> L <sub>7</sub> <u>18</u>	

Remarks P6S installed in former tank area. Initially, hit refusal at  
13'. Offset location of P6S by ~ 3'. Cement apron placed around riser

Inspected By

Mark Houlden

WOODWARD - CLYDE CONSULTANTS



# PIEZOMETER INSTALLATION REPORT

Project CIBA-GEIGY

Piezometer No. P6M

Project No. 87X4660

Installed By ABLE DRILLING CO.

Location Production Area (Near RR. Tracks)

Date 13 APR. 88 Time 7:30 - 1:30 pm

Method of Installation Augered to 23 FT → Hammered to 40 FT.

(2' Samples taken every 5 FT between 15 and 22 FT)

15' Samples : " every 5 FT between 25 and 40 FT)

No samples beyond 40 FT - hammered to 42.5 (Possibly bedrock)

## LOG OF BORING AND PIEZOMETER

BORING			PIEZOMETER	
Depth in ft.	Description	Symbol	Type of Piezometer	
	For Details: See Boring Log for P6I.		<u>3' galvanized steel piezometer</u>	
			Ground Elev. <u>21.39'</u>	Top of Riser Elev. <u>22.01'</u>
			<u>Vented Cap</u>	
			ID. of Riser Pipe <u>1 1/4"</u>	
			Type of Pipe <u>galvanized steel</u>	
			Type of Backfill Around Riser <u>Soil Cuttings</u>	
			Top of Seal Elev. <u>N/A</u>	
			Type of Seal Material <u>N/A</u>	
			Top of Filter Elev. <u>N/A</u>	
			Type of Filter Material <u>Inert Soil</u>	
			Size of Openings <u>80 gauge</u>	
			Diameter of Piezometer Tip <u>1 1/4"</u>	
			Bottom of Piez. Elev. <u>18.6'</u>	
			Bottom of Boring Elev. <u>18.6'</u>	
			Diameter of Boring <u>NA</u>	
	<p>WATER TABLE : ~ 14 FT</p> <p>No samples available beyond 40 FT - hole collapsed. Hammered to "possibly bedrock" (~ 42.5')</p>	<p>L1 = <u>0.6'</u></p> <p>L2 = <u>NA</u></p> <p>L3 = <u>NA</u></p> <p>L4 = <u>NA</u></p> <p>L5 = <u>38.7'</u></p> <p>L6 = <u>3'</u></p> <p>L7 = <u>40'</u></p>		

Remarks Cement apron placed around riser

Inspected By L. Morisi

WOODWARD-CLYDE CONSULTANTS

# PIEZOMETER INSTALLATION REPORT

Project CIBA - GEIGY Piezometer No. P-7S-A  
 Project No. 87X4660 Installed By Atla Drilling Location Wastewater treatment area, SE corner  
 Date 4/12/88 Time 122 PM  
 Method of Installation Augured down to 3', water table is  $\approx$  4' based on data from existing piezometer. Well point pushed piezometer down to 6-9'.

## LOG OF BORING AND PIEZOMETER

BORING			PIEZOMETER	
Depth in ft.	Description	Symbol	Type of Piezometer	Ground Elev.
0	Brown - dark brown sandy SILT with clay, moist. (Observations based on return of soil cuttings during drilling).		<u>3' galvanized steel piezometer</u>	<u>10.98'</u>
5				<u>Top of Riser Elev. 12.55'</u>
				<u>Vented Cap</u>
				<u>ID. of Riser Pipe <math>1\frac{1}{4}"</math></u>
				<u>Type of Pipe <u>galvanized</u></u>
			<u>Type of Backfill Around Riser <u>Soil cuttings</u></u>	
			<u>Top of Seal Elev. <u>NA</u></u>	
			<u>Type of Seal Material <u>NA</u></u>	
			<u>Top of Filter Elev. <u>NA</u></u>	
			<u>Type of Filter Material <u>Smaller soil</u></u>	
			<u>Size of Openings <u>80 gauge</u></u>	
			<u>Diameter of Piezometer Tip <u><math>1\frac{1}{4}"</math></u></u>	
			<u>Bottom of Piez. Elev. <u>1.98'</u></u>	
			<u>Bottom of Boring Elev. <u>1.98'</u></u>	
			<u>Diameter of Boring <u>NA</u></u>	

Remarks Water table approximated from existing piezometer and elevation of river.  
Cement apron placed around riser

Inspected By

*M. Houlday*

WOODWARD - CLYDE CONSULTANTS

# PIEZOMETER INSTALLATION REPORT

Project CIBA-GEIGY Piezometer No. P-7S-B  
 Project No. 87X4660 Installed By Able Drilling Location Wastewater Treatment Area, SE Corner  
 Date 4/15/88 Time 2:30 PM  
 Method of Installation Augered (solid stem) down to 15'. Took a split spoon sample from 15'-17'. Hit clay layer at ~16'.

## LOG OF BORING AND PIEZOMETER

### BORING

Depth  
in ft.

Description

Symbol

Brown - dark brown sandy  
SILT with clay, moist.

Same as above,  
wet.

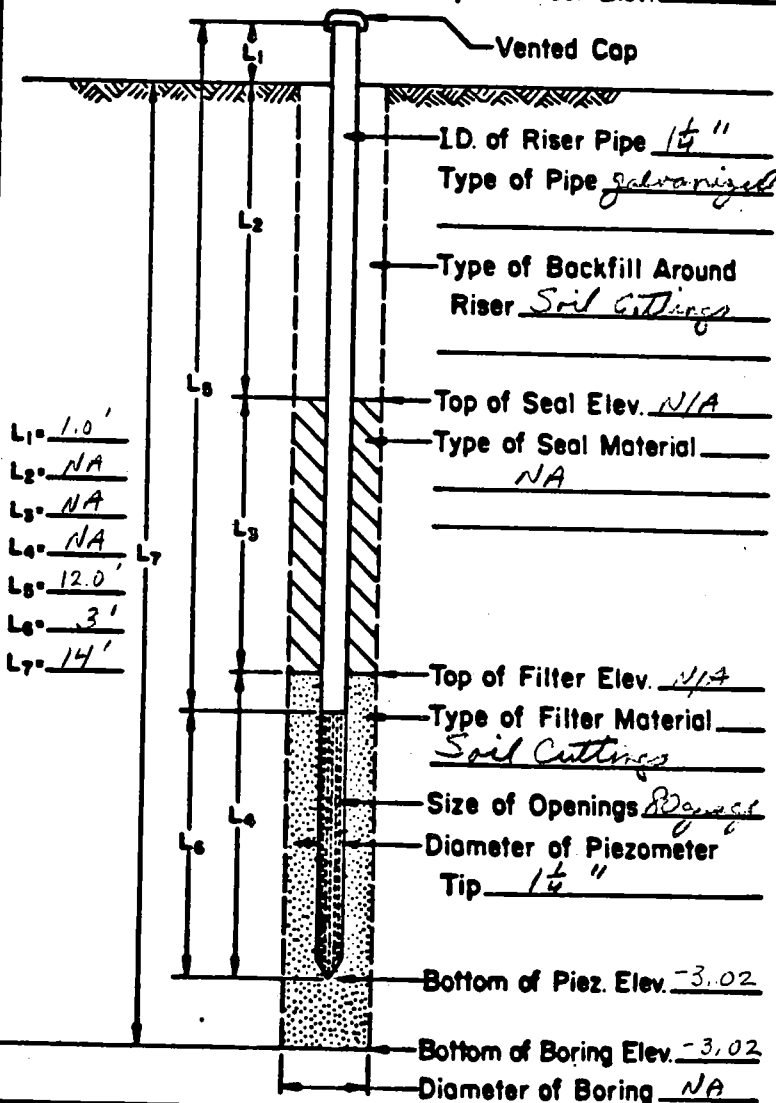
(Observations based on return of  
soil cuttings during drilling).

### PIEZOMETER

Type of Piezometer 3' galvanized steel piezometer

Ground Elev. 10.98'

Top of Riser Elev. 11.99'



Remarks Cement apron placed around riser

Inspected By M. Houlden

WOODWARD-CLYDE CONSULTANTS

# PIEZOMETER INSTALLATION REPORT

Project CIBA - GEIGY

Piezometer No. PBS

Project No. 87x4660

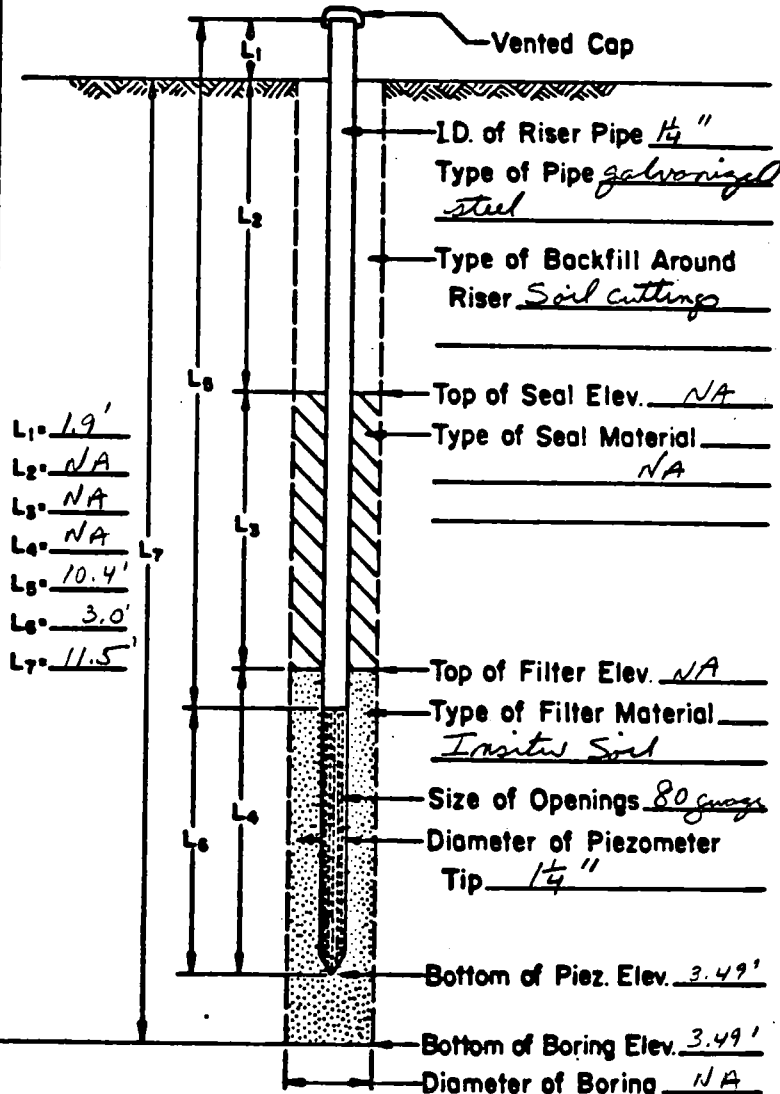
Installed By Atle Drilling

Location Waste Water Treatment Plant, SW Corner

Date 4/12/88 Time 1:30 PM

Method of Installation Augered down to water table ( $\approx 6.5'$ ). Inserted well point, pushed piezometer down to 11.5'

## LOG OF BORING AND PIEZOMETER

BORING			PIEZOMETER	
Depth in ft.	Description	Symbol	Type of Piezometer <u>3' galvanized steel piezometer</u>	
			Ground Elev. <u>14.99'</u>	Top of Riser Elev. <u>16.93'</u>
0	FILL - brown - dark brown sandy silt with clay, moist. (Observations based on return of soil cuttings during drilling).		 <p>Vented Cap</p> <p>ID. of Riser Pipe <u>1 1/4"</u></p> <p>Type of Pipe <u>galvanized steel</u></p> <p>Type of Backfill Around Riser <u>Soil cuttings</u></p> <p>Top of Seal Elev. <u>NA</u></p> <p>Type of Seal Material <u>NA</u></p> <p>Top of Filter Elev. <u>NA</u></p> <p>Type of Filter Material <u>Inert Soil</u></p> <p>Size of Openings <u>80 gauges</u></p> <p>Diameter of Piezometer Tip <u>1 1/4"</u></p> <p>Bottom of Piez. Elev. <u>3.49'</u></p> <p>Bottom of Boring Elev. <u>3.49'</u></p> <p>Diameter of Boring <u>NA</u></p>	
5				
			<p><math>L_1 = 1.9'</math></p> <p><math>L_2 = NA</math></p> <p><math>L_3 = NA</math></p> <p><math>L_4 = NA</math></p> <p><math>L_5 = 10.4'</math></p> <p><math>L_6 = 3.0'</math></p> <p><math>L_7 = 11.5'</math></p>	

Remarks Area has been filled in. Hit water table at 6.5',  $\approx$  the same elevation of the river. Cement apron placed around riser

Inspected By M. Houlding

# PIEZOMETER INSTALLATION REPORT

Project CIBA - GEIGY  
 Project No. 87X 9660 Installed By ABLE  
 Piezometer No. P-95  
 Location Center of Waste-Water Treatment Area  
 Date 7/12/88 Time 9:00 pm

Method of Installation Augured down to 7' = inserted well tip and pushed down to 12'.

## LOG OF BORING AND PIEZOMETER

BORING			PIEZOMETER	
Depth in ft.	Description	Symbol	Type of Piezometer	Ground Elev.
			<u>3' galvanized steel piezometer</u>	<u>14.65'</u>
				Top of Riser Elev. <u>16.16'</u>
			Vented Cap ID. of Riser Pipe <u>1 1/4"</u> Type of Pipe <u>galvanized steel</u> Type of Backfill Around Riser <u>Soil C. Hays</u> Top of Seal Elev. <u>N/A</u> Type of Seal Material <u>N/A</u> Top of Filter Elev. <u>N/A</u> Type of Filter Material <u>crushed soil</u> Size of Openings <u>80 mesh</u> Diameter of Piezometer Tip <u>1 1/4"</u> Bottom of Piez. Elev. <u>2.65'</u> Bottom of Boring Elev. <u>2.65'</u> Diameter of Boring <u>N/A</u>	
			L <sub>1</sub> <u>1.5'</u> L <sub>2</sub> <u>N/A</u> L <sub>3</sub> <u>N/A</u> L <sub>4</sub> <u>N/A</u> L <sub>5</sub> <u>10.5'</u> L <sub>6</sub> <u>3'</u> L <sub>7</sub> <u>12'</u>	

Remarks Cement apron placed around riser

Inspected By M. H. / L. M.

# PIEZOMETER INSTALLATION REPORT

Project CIBA - GEIGY Piezometer No. P-105  
 Project No. 87K4660 Installed By ABLE Location Henrich Area - along river  
 Date 7/12/88 Time 4:00 pm

Method of Installation Hugered down to a depth of 7 ft. Inserted well  
tip and pushed down to 12 ft.

## LOG OF BORING AND PIEZOMETER

BORING			PIEZOMETER	
Depth in ft.	Description	Symbol	Type of Piezometer	Ground Elev.
			<u>3' galvanized steel piezometer</u>	<u>12.69</u>
				Top of Riser Elev. <u>14.20'</u>
			Vented Cap ID. of Riser Pipe <u>1 1/4"</u> Type of Pipe <u>galvanized steel</u> Type of Backfill Around Riser <u>Soil Cuttings</u> Top of Seal Elev. <u>N/A</u> Type of Seal Material <u>N/A</u> Top of Filter Elev. <u>N/A</u> Type of Filter Material <u>crushed soil</u> Size of Openings <u>80 gauge</u> Diameter of Piezometer Tip <u>1 1/4"</u> Bottom of Piez. Elev. <u>0.69'</u> Bottom of Boring Elev. <u>0.69'</u> Diameter of Boring <u>NA</u>	
			L <sub>1</sub> = <u>1.5'</u> L <sub>2</sub> = <u>NA</u> L <sub>3</sub> = <u>NA</u> L <sub>4</sub> = <u>NA</u> L <sub>5</sub> = <u>11.5'</u> L <sub>6</sub> = <u>3'</u> L <sub>7</sub> = <u>12'</u>	

Remarks Cement apron placed around riser

Inspected By M.H. / L.M.  
 WOODWARD - CLYDE CONSULTANTS

# PIEZOMETER INSTALLATION REPORT

Project CIBA - GETGY Piezometer No. P-11 S  
 Project No. 87X4660 Installed By ABLE DRILL CO. Location Northwestern part of Wastewater Treatment Area  
 Date 13 APR 88 Time 3:00 - 4:00  
 Method of Installation Augered to a depth of 4.5 ft. - hammered piezometer (wellpoint) to 10 ft.

## LOG OF BORING AND PIEZOMETER

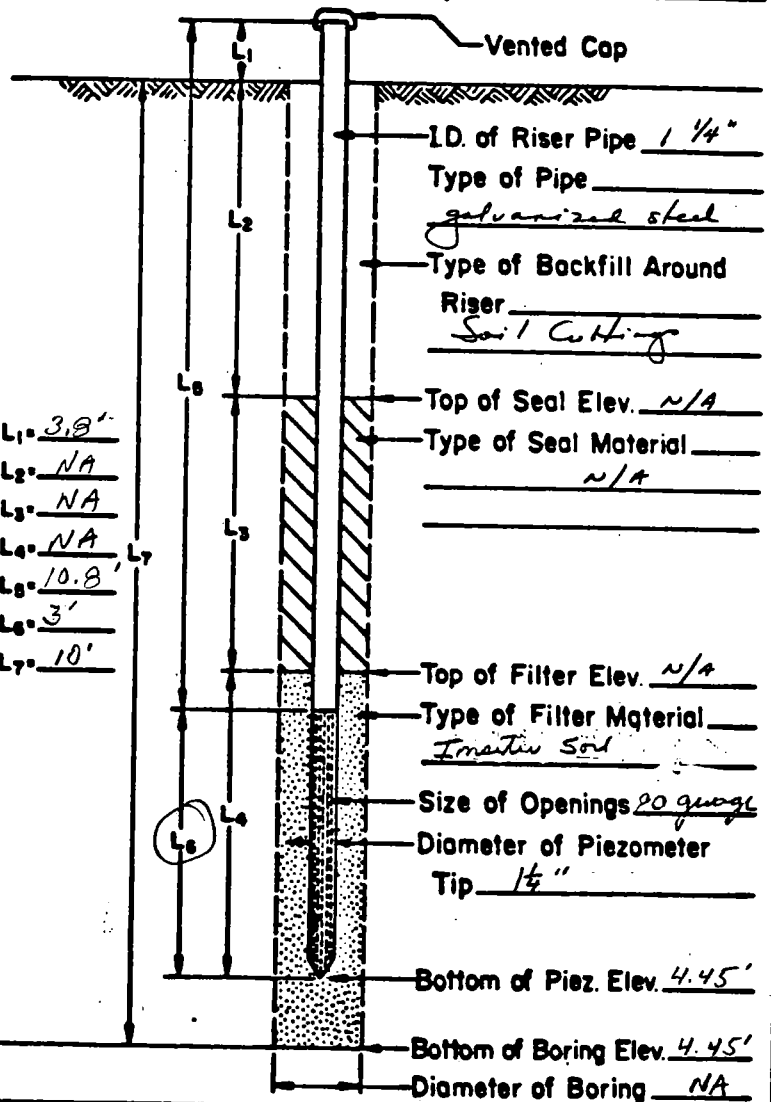
### BORING

Depth in ft.	Description	Symbol
0	Dark brown to black coarse sand + med. sand + pebbles (organics)	
~4'	Same as above - but pebbles become more abundant (0.25" to 1" diam.). Color becomes dark grey (first sign of moisture)	
4.5	Sign. locally moist - water table.	
	(Observations based on return of soil cuttings during drilling.)	

### PIEZOMETER

Type of Piezometer 3' galvanized steel piezometer

Ground Elev. 14.45' Top of Riser Elev. 18.29'



Remarks Moved hole ~ 1 ft. north of orange stake marker.  
Cement apron placed around riser

Inspected By L. MORIS



# PIEZOMETER INSTALLATION REPORT

Project CIBA - GEIGY Piezometer No. P12 S-A  
 Project No. 87X 4660 Installed By ABLE DRILL CO. Location NW corner of Waste Water Treatment Area  
 Date 13 APR. 88 Time 9:00 - 4:30 pm  
 Method of Installation Augered to 7 FT; hammered well tip to 12 FT. (Screen located between 9-12 FT).

## LOG OF BORING AND PIEZOMETER

BORING			PIEZOMETER	
Depth in ft.	Description	Symbol	Type of Piezometer <u>3' galvanized steel piezometer</u>	
			Ground Elev. <u>14.17</u>	Top of Riser Elev. <u>16.00</u>
0	Dark brown to black medium sand, silt, river amount of pebbles (organics)		<p>             Vented Cap              ID. of Riser Pipe <u>1 1/4"</u>              Type of Pipe <u>galvanized steel</u>              Type of Backfill Around Riser <u>Soil Cuttings</u>              Top of Seal Elev. <u>N/A</u>              Type of Seal Material <u>N/A</u>              Top of Filter Elev. <u>N/A</u>              Type of Filter Material <u>INSITU SOIL</u>              Size of Openings <u>80 mesh</u>              Diameter of Piezometer Tip <u>1/2"</u>              Bottom of Piez. Elev. <u>2.17</u>              Bottom of Boring Elev. <u>2.17</u>              Diameter of Boring <u>NA</u> </p>	
4'	↓ Lt. to med. brown coarse to medium sand, silt + pebbles.			
5'	↓ Dark brown to black medium sand, silt, few pebbles. (Very first part of moist)			
6'	↓ Dark brown to black fine sand + silt			
7'	↓ SAME - Moist (muddy) (Observations based on return of soil cuttings during drilling)			

Remarks Cement spoon placed around riser

Inspected By L. Morrison

# PIEZOMETER INSTALLATION REPORT

Project CIBA - GEIGY

Piezometer No. P-12S-B

Project No. 87x4660

Installed By Able Drilling

Location Form-Tank Area, NW corner

Date 4/14/88 Time 1:30 PM

Method of Installation Augered down to 19'. Took split spoon samples down to 26.5'. Encountered a soft wet clay from 15-26.5. Clay layer is at least 11.5' thick. Backfilled to 15'. Installed well point from 12-15'.

## LOG OF BORING AND PIEZOMETER

### BORING

### PIEZOMETER

Type of Piezometer 3' galvanized steel piezometer

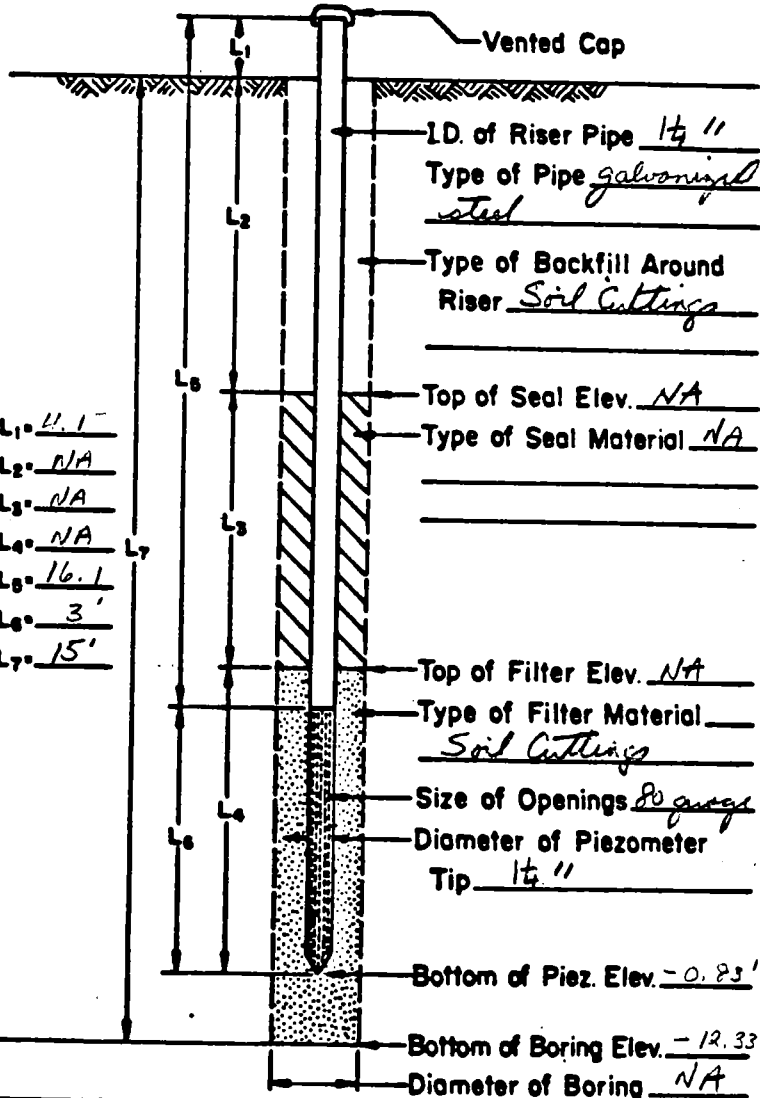
Ground Elev. 14.17

Top of Riser Elev. 18.24

Depth  
in ft.

Description

Symbol



Dark brown & sandy SILT with some clay, to gravel moist.  
(Observations are based on return of soil cuttings during drilling).

Remarks Cement apron placed around riser

Inspected By

P. Houlden

# PIEZOMETER INSTALLATION REPORT

Project CIBA-GEIGY

Project No. 87X4660

Installed By Atke Drilling

Piezometer No. P-135

Location Production area - between buildings  
25 + 26

Date 4/15/88 Time 9:00 AM

Method of Installation Augered down to 15' (using solid stem auger). Water table not  
obvious from cuttings. Removed drill rods from hole, measured water at 9'.  
Backfilled boring; installed well point from 11-14'.

## LOG OF BORING AND PIEZOMETER

### BORING

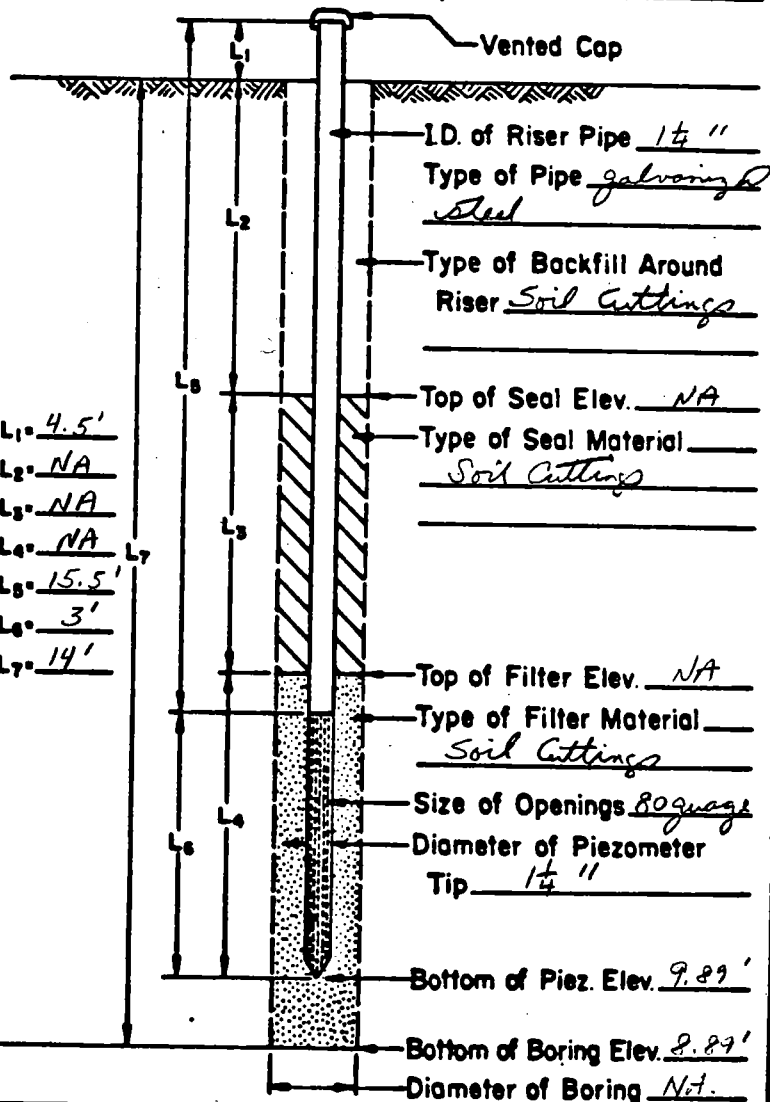
Depth in ft.	Description	Symbol
0	FILL - brown clayey silt with some f sand and gravel, moist	
5		
10	FILL - light brown - tan f sand, some silt, moist  (Observations based on return of soil cuttings during drilling).	

### PIEZOMETER

Type of Piezometer 3' galvanized steel piezometer

Ground Elev. 23.89'

Top of Riser Elev. 23.43'



Remarks Measured water in boring at 9'. Cement apron placed around  
riser

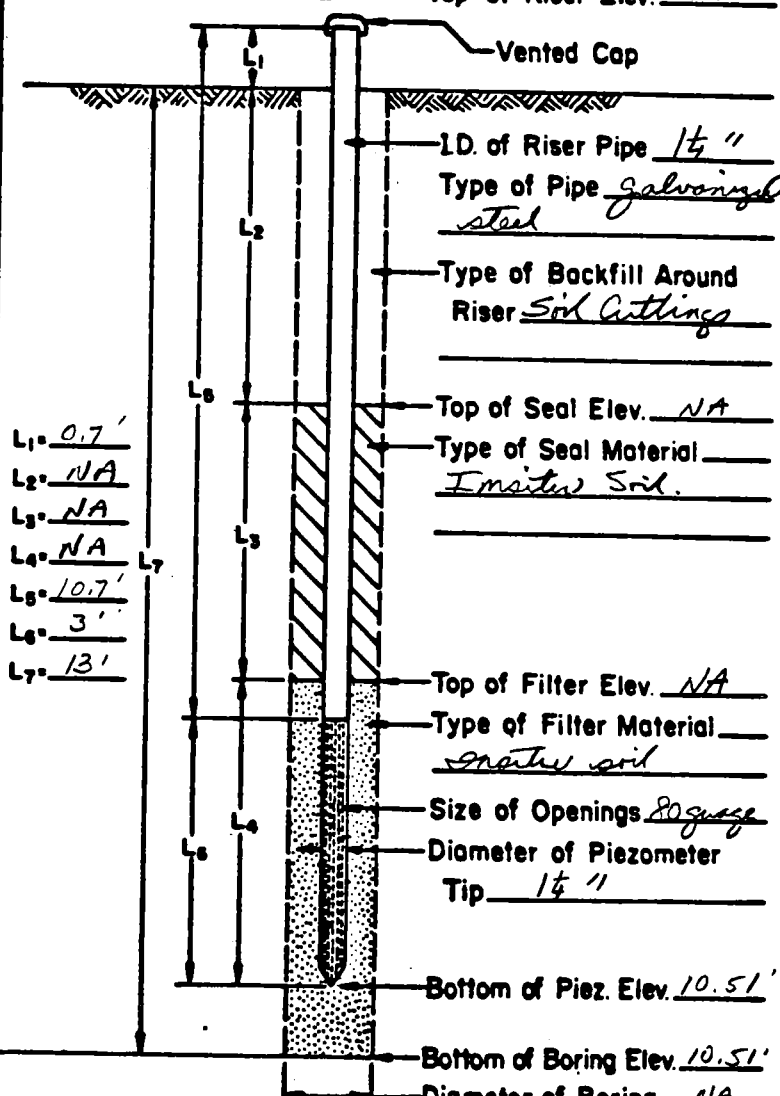
Inspected By PC Donlavy

WOODWARD-CLYDE CONSULTANTS

# PIEZOMETER INSTALLATION REPORT

Project CIBA - GEIGY Piezometer No. P14S  
 Project No. 87X 4660 Installed By Able Drilling Location NW corner of Production Area  
 Date 4/15/88 Time 8:15 AM  
 Method of Installation Augered down to 1'; inserted well point, pushed and  
hammered piezometer down to 13'. Water table was 8' as observed  
in split spoon samples for P14D.

## LOG OF BORING AND PIEZOMETER

BORING			PIEZOMETER	
Depth in ft.	Description	Symbol	Type of Piezometer	3' galvanized steel piezometer
			Ground Elev.	23.51'
			Top of Riser Elev.	24.16'
0	Brown - dark brown clayey SILT with tr. of sand and gravel, moist. (Observations based on return of soil cuttings during drilling)			
1			Vented Cap I.D. of Riser Pipe <u>1 1/4"</u> Type of Pipe <u>galvanized steel</u> Type of Backfill Around Riser <u>Soil Cuttings</u> Top of Seal Elev. <u>NA</u> Type of Seal Material <u>Imitation Soil</u> Top of Filter Elev. <u>NA</u> Type of Filter Material <u>native soil</u> Size of Openings <u>80 mesh</u> Diameter of Piezometer Tip <u>1 1/4"</u> Bottom of Piez. Elev. <u>10.51'</u> Bottom of Boring Elev. <u>10.51'</u> Diameter of Boring <u>NA</u>	
			L <sub>1</sub> = <u>0.7'</u> L <sub>2</sub> = <u>NA</u> L <sub>3</sub> = <u>NA</u> L <sub>4</sub> = <u>NA</u> L <sub>5</sub> = <u>10.7'</u> L <sub>6</sub> = <u>3'</u> L <sub>7</sub> = <u>13'</u>	

Remarks Cement apron placed around riser

# PIEZOMETER INSTALLATION REPORT

Project CIBA - GEIGY

Piezometer No. P-14D

Project No. 87X4660

Installed By Atle Dierling

Location NW corner of Production Area

Date 4/15/88 Time 1:52 PM

Method of Installation Augered and washed and drove casing to 58.5'. Backfilled borehole to 47'. Installed well point from 47 - 50' in loosely consolidated material.

## LOG OF BORING AND PIEZOMETER

### BORING

Depth  
in ft.

Description

Symbol

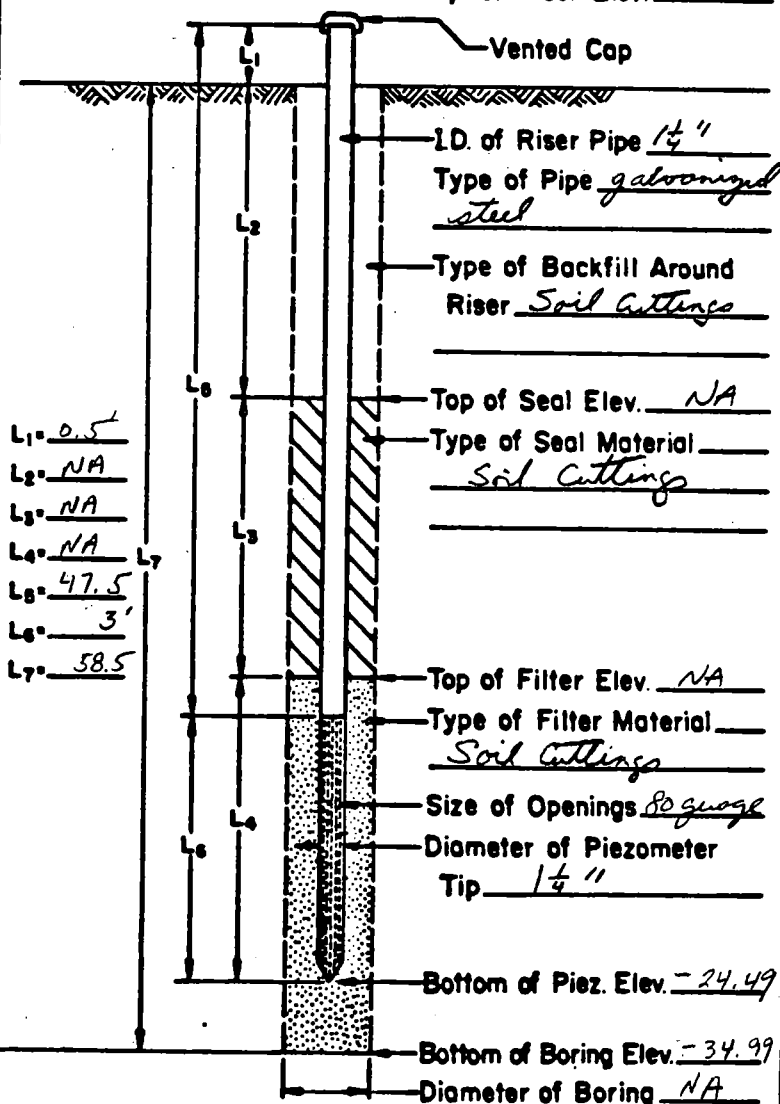
*See boring log P14D*

### PIEZOMETER

Type of Piezometer 3' galvanized steel piezometer

Ground Elev. 23.51'

Top of Riser Elev. 24.00'



Remarks Installed piezometer just above dense till in an unconsolidated till like material. Cement apron placed around riser

Inspected By R. Houlday

WOODWARD - CLYDE CONSULTANTS

## *Chapter Two*

## VOLUME 1 - CHAPTER 2

### STRATEGIC PLAN

#### INTRODUCTION

---

Chapter 1, the Current Assessment Summary Report, summarized information pertinent to the RCRA Facility Investigation (RFI). It discussed:

- o the facility history;
- o the RCRA investigation history;
- o the facility's environmental setting;
- o the SWMUs, AOCs, and AAOIs;
- o previous investigations;
- o data needs; and
- o conclusions and recommendations for further study.

This chapter presents the strategies for meeting the objectives of the RFI. It has five sections:

- o Section 1 -- the Public Health and Environmental Risk Evaluation (PHERE) work plan describes how the potential human health and environmental risks associated with past facility releases will be evaluated.
- o Section 2 -- the Media Protection Standards (MPS) work plan describes the work needed in order to propose Media Protection (i.e., clean-up) Standards for hazardous waste (or hazardous constituents) released from the SWMUs and AOCs identified in the Order.
- o Section 3 -- the Corrective Measures Risk Evaluation work plan proposes alternative corrective measures that will meet the Media Protection Standards.



- o Section 4 -- contains the references cited in the PHERE, MPS, and Corrective Measures Risk Evaluation work plans.
- o Section 5 -- the Project Management Plan describes technical goals and schedules, as well as how project performance toward these goals and schedules will be monitored. It covers project organization, responsibilities, scope of work, schedules of performance, and the products to be delivered.

**VOLUME 1 - CHAPTER 2  
STRATEGIC PLAN**

**SECTION 1  
PUBLIC HEALTH AND ENVIRONMENTAL RISK  
EVALUATION WORK PLAN**

---

**1.1 INTRODUCTION**

The purpose of this Public Health and Environmental Risk Evaluation (PHERE) work plan is to describe the work that will be conducted to evaluate the potential human health and environmental risks associated with potential exposure to hazardous waste and/or hazardous constituents possibly released from the Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) at the CIBA-GEIGY facility in Cranston, Rhode Island (the facility or the site). Definitions of the SWMUs and AOCs were presented in Chapter 1, the Current Assessment Summary Report. The approach used in this evaluation has the following elements:

- o background investigation;
- o selection of Constituents of Concern;
- o migration pathway analysis;
- o exposure scenario characterization;
- o exposure assessment; and
- o risk characterization.

**1.2 OBJECTIVES**

The PHERE has been designed to meet, at a minimum, the following requirements of the Order:

- o identification of any chemical source terms (e.g., SWMUs) and affected media at the facility;
- o selection of Constituents of Concern;
- o estimation of exposure point concentrations in relevant media, taking into consideration present and potential future uses of the site;
- o comparison of exposure point concentrations to relevant exposure guidelines; and
- o integration of risk (e.g., comparing intake levels to health-based criteria).

### 1.3 STRATEGY

The PHERE serves to evaluate whether site-related chemicals found at the SWMUs and AOCs present a possible risk to public health and the environment. In the background investigation the analytical data will be evaluated to characterize the SWMUs and AOCs, in terms of the type and quantity of chemicals present in the environmental media. Constituents of Concern will be selected if necessary. These compounds will consist of the chemicals which have the greatest potential to impact human health or other environmental populations.

The migration pathway analysis will identify site-specific chemical transport pathways and characterize the media relevant to that transport. The findings will be used to estimate potential exposure of human and environmental receptors to site-related chemicals. Potential receptor populations will be identified based on the migration pathway analysis. Exposure scenarios will be developed to estimate the potential exposures for all relevant pathways for human and environmental populations. Estimates of potential daily intake will be made using actual or estimated exposure point concentrations combined with the various exposure scenarios.

The potential for human health impacts will include an evaluation of both the carcinogenic and noncarcinogenic health impacts. Evaluation of potential health

effects will include the estimation of the potential increase in carcinogenic risk and the characterization of the long-term health effects from exposure to noncarcinogenic compounds. The potential for adverse effects to the environment will also be estimated for the various media and related receptors using exposure point concentrations.

Implications of the estimated risks associated with potential exposures will be presented.

#### 1.4 JUSTIFICATION

These work plans incorporate applicable approaches for health and environmental risk assessments as presented in the following documents:

- o Risk Assessment Guidance for Superfund, Vol 1: Human Health Evaluation Manual (HHEM) (EPA, 1989d);
- o Risk Assessment Guidance for Superfund, Vol 2: Environmental Evaluation Manual (EPA, 1989/##?e);
- o EPA Region I Supplemental Risk Assessment Guidance for the Superfund Program: Part 1 - Supplemental Guidance on Superfund Public Health Risk Assessments; Part 2 - Guidance for Ecological Risk Assessments (Draft Final) (EPA, 1989f);
- o Integrated Risk Information (IRIS) (EPA, most recent monthly update);
- o Health Effects Assessment Summary Tables, Fourth Quarter, FY 1989 (EPA, 1989b or future update);
- o Superfund Exposure Assessment Manual (EPA, 1988b);

- o Methods for Evaluating the Attainment of Cleanup Standards, Vol 1: Soils and Solid Media (EPA, 1989c); and
- o Administrative Order on Consent (Order) No. I-88-1088, issued to CIBA-GEIGY (1989).

## 1.5 PUBLIC HEALTH AND ENVIRONMENTAL RISK EVALUATION

### 1.5.1 Historical Data Review

Before conducting the PHERE, relevant historical data and other information will be gathered during a site visit and reviewed. Information will be obtained concerning:

- o the background of the site;
- o disposal histories;
- o on-site and off-site chemical analysis data;
- o topography and hydrogeology of the area; and
- o demographics and environmental settings.

Sampling efforts and chemical characterization of on-site areas, the off-site area, and the Pawtuxet River area for Phase I are addressed in Chapter 3 of Volume 1 -- the Facility Investigation Work Plan. The Facility Investigation is designed to ensure that the sampling and analysis program will satisfy the data requirements of the PHERE.

### 1.5.2 Source Term Characterization

#### Solid Waste Management Units and Areas of Concern

The characterization of potential chemically affected areas of the CIBA-GEIGY facility will be conducted in Volume 1 of the RCRA Facility Investigation Proposal as detailed in Section 4 (Release Characterization) of Chapter 3 -- the Facility Investigation Work Plan. The sampling and analysis program for the SWMUs and other AOCs will address:

- o soil;
- o ground water;
- o surface water; and
- o sediment.

The site was razed in 1986; therefore, air will not be sampled. However, air will be evaluated on a potential migration and exposure pathway in the PHERE.

#### Off-Site Characterization

The characterization of potential affected off-site areas will be conducted as detailed in Section 4 (Release Characterization) of Chapter 3 -- the Facility Investigation Work Plan. The media to be sampled and analyzed are:

- o soil;
- o surface water; and
- o sediment.

Specified schools and nursing homes listed in the Order and other public use facilities will be investigated as off-site sampling areas.

### 1.5.3 Background Study

A chemical background study will be conducted to compare site analytical data on SWMU by SWMU basis with the existing background of chemical concentrations in the surrounding communities. The objective is to characterize the regional background of chemicals both naturally occurring (e.g., metals) and man-made. The data will be used to assist in determining the on-site concentrations of naturally occurring materials that are significantly above background, and to establish a regional frame of reference for evaluating the quantities of man-made chemicals observed on site.

Four locations were selected as described below with at least two soil samples to be collected at each location. Soil samples will be collected from the surficial 6 to 12 inches and analyzed for the Appendix IX analyte list, fingerprint compound, and total organic carbon (see Chapter 3, Table 4-4). Soil physical characteristics such as grain size will also be measured. The four locations selected are:

- o the Sanders Street School in Cranston;
- o the New Dutemple School on Pontiac Avenue in Cranston;
- o the Pilgrim High School on Pontiac Avenue in Cranston;
- o the Wyman school in Warwick.

The Waterman School in Warwick will serve as a backup location to the four selected above. The selection criteria for these locations were:

- o located predominantly upwind from the site based on the wind rose in Chapter 1, the Current Assessment Summary Report (Figure 2-6); and
- o readily accessible, publicly owned land within about 3 miles of the site.



#### 1.5.4 Environmental Receptor Investigation

The objective of the environmental receptor investigation is to characterize environmental receptors potentially affected if chemicals from the CIBA-GEIGY facility are being released to the environmental media. The following tasks will be undertaken as part of this investigation as suggested by EPA Region 1 (EPA, 1989f):

- o review available background information;
- o perform a site reconnaissance by a field biologist; and
- o identify potential chemically affected indicator species and habitats.

The Pawtuxet River runs through the site to an estuarial cove downstream (Figure A-1, Appendix A). Initial review of site data indicates that biota from the river are the receptors most likely to be affected by possible chemical releases from the SWMUs and AOCs. Therefore, the investigation of environmental receptors will seek to characterize the toxicity of surface waters and sediments from the river in representative species. Bioassays will use samples of surface water and sediment taken from two locations upstream of the CIBA-GEIGY site, six locations at the site, and one location downstream (Chapter 3, Figure 4-3). Duplicate samples of sediment will be collected, one for bioassay and the other for possible future analytical chemistry. The water flow in the Pawtuxet River will be measured at the time of sampling and compared with the seven day low flow for a ten year period (7Q10).

The toxicity of sediment samples will be evaluated in ten day bioassays using the larvae of a midge (Chironomus tentenus). Pore water from sediments will be assayed in a 48-hour exposure to a daphnid (Ceriodaphnia dubia). The toxicity of surface waters will be evaluated with seven day bioassays using the same daphnid (C. dubia) and the fathead minnow (Pimephales promelas). The longer bioassays will include observations for mortality at 48 hours. Full protocols for these tests will be developed with consultation from EPA Region I. If excess mortality is seen in the bioassays, the EPA project manager will be consulted.

Using appropriate reference sources, information will be collected on the indigenous flora and fauna in the area of the CIBA-GEIGY facility. Endangered species will be included. Both flora and fauna will be considered as potential on-site environmental receptors because any evidence of potential environmental stress will be most evident on or immediately adjacent to the CIBA-GEIGY facility. In addition, wild game will be considered as a potential exposure pathway.

#### **1.5.5 Selection of Constituents of Concern**

The site-specific Constituents of Concern will be selected from:

- o detected Appendix IX chemicals; and
- o detected chemicals unique to the CIBA-GEIGY facility and not listed in Appendix IX, which will be referred to as "fingerprint" compounds.

#### **Selection of Fingerprint Compounds**

Fingerprint compounds are specific chemicals unique to the activities at the CIBA-GEIGY facility in Cranston, Rhode Island. This section identifies the fingerprint compounds and describes the rationale by which they were chosen for analysis. The selection of fingerprint compounds was not a requirement of the Order, but was incorporated into this work plan to ensure a more complete investigation. In addition, fingerprint compounds were necessary to satisfy the intent of the Order.

Fingerprint compounds were selected based on:


- o a review of chemical production and usage records to identify those chemicals that are unique to the facility but are not on Appendix IX;
- o the toxicology of these chemicals; and

- o the physicochemical properties of these chemicals, including their potential for degradation and transport.

The raw materials and intermediates (including 15 Appendix IX chemicals), as well as the final products used or manufactured at the facility, were scored for three criteria -- toxicity, mobility, and persistence. The scores for each chemical were multiplied across criteria to obtain factor numbers for each chemical. The factor numbers for chemicals were ranked in descending order; the final chemical products of the facility were ranked separately from the raw materials and intermediates used at the facility.

For raw materials and intermediates, Appendix IX chemicals received the highest scores. It was determined that the potential health risk arising from the raw materials and intermediates will be evaluated adequately by analyzing for Appendix IX chemicals.

Scores for the final products were ranked within product categories. The following chemicals were selected as fingerprint compounds:

- 
- o Imipramine (Tofranil)
  - o Phenylbutazone (Butazolidin)
  - o Propazine
  - o Tinuvin 327 *BEST QA/QC PROFILE*

Additional candidate fingerprint compounds include <sup>*-NO-*</sup> Irgasan CF3, <sup>*YES*</sup> Irgasan DP300, and their related by-products. One or both of these will be selected as fingerprint compounds, depending on the outcome of the matrix recovery studies described in Chapter 4, Part B -- the Quality Assurance Project Plan.

#### Target Chemical Selection

Appendix IX chemicals and the fingerprint compounds form the initial list of all chemicals to be sought. The environmental media samples will be analyzed for

these chemicals. After the second round of sampling and analysis for these chemicals is completed, the results of the chemical analyses will be reviewed for chemicals which may be dropped from further consideration as described in the Sampling and Analytical Work Plan. Those remaining on the list will be referred to as "target chemicals." The term "target chemical" is not a defined term used by EPA, but is used in this report to refer to those chemicals which will be considered for selection as Constituents of Concern. The following guidelines are proposed for eliminating chemicals:

- o The chemical is not detected in any of the media samples.
- o A naturally-occurring chemical (e.g., metals) is detected in one or more media, but is at or below the background levels (from samples taken at EPA-approved background locations) for that specific medium. Man-made chemicals detected in background studies will be carried through the risk evaluation, but will be addressed relative to their background occurrence.
- o The chemical is a common laboratory contaminant (i.e., acetone or methylene chloride) and the amounts detected in the samples are within one order of magnitude of the maximum amount detected in the blanks.
- o The chemical is found in laboratory blanks and the amount detected in the samples are less than five times the maximum amount detected in any blank.

These guidelines are proposed so that resources may be focused on further characterization of the chemicals in the various media after Phase I sampling and analyses. In addition, the results of these analyses will be used to assist in the selection of Constituents of Concern.

#### Constituents of Concern Selection Methodology

The list of potentially site-related chemicals at the CIBA-GEIGY facility in Cranston, Rhode Island, is expected to be manageable because the data will be processed using computer spreadsheets. If an excessively large number of

chemicals are found and the data indicate that it is inappropriate to attempt to model and review all the chemicals detected in the environmental media, then Constituents of Concern will be selected. The selection of Constituents of Concern will be modeled on the approach described in the HHEM (EPA, 1989d). The objective of this task is to review the analytical database and to identify those site-specific compounds with the highest potential for harm to human health or the environment either as a result of accidental release or as residual occurrences.

Target chemicals detected within environmental media associated with each SMWU, AOCs, and off-site sampling locations will be summarized according to the HHEM methodology (EPA, 1989d). Target chemicals which have a carcinogenic ranking of A, B<sub>1</sub>, or B<sub>2</sub> by the Carcinogenic Assessment Group (CAG) of EPA will automatically become Constituents of Concern and will be considered separately from target chemicals which are considered to be noncarcinogenic.

After this primary selection, the noncarcinogenic chemicals and Group C carcinogens, if any, will be selected using a concentration-toxicity screen, as described in HHEM (EPA, 1989d). The risk factor for each chemical will be calculated by dividing its concentration in a medium by an appropriate reference value, such as a reference dose (RfD). The RfD is an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without appreciable risk of deleterious effects during a lifetime. RfDs will be obtained from the most recent update of IRIS, EPA's on-line database for risk and toxicity information. If an RfD is not available, then EPA Region I guidance will be used to select an appropriate value (EPA Region I, 1989). In descending order of priority, the sources approved by EPA Region I are:

1. IRIS (most recent update);
2. HEAST (most recent update);
3. Values derived under the Safe Drinking Water Act (DWELL, MCLG, etc.), as shown in the "Health Advisories" published by EPA's Office of Drinking Water;

4. Acceptable Intake Chronic (AIC), as shown in "Health Effects Assessments" published by EPA's Office of Emergency and Remedial Response;
5. Ambient Water Quality Criteria (as published in the Federal Register); and
6. Values derived by the National Academy of Sciences (ADI, SNARL, etc.).

If appropriate values cannot be found, CIBA-GEIGY will propose a site-specific RfD after consultation with the EPA. Chemicals will then be evaluated based on their mobility in soil, water, air, between media, and the persistence and potential transformation of the compounds detected in the different media. The final selection will be made based on the chemical's risk factor; however, the physicochemical properties may also be brought into consideration during the selection process (EPA, 1989d).

The use of Constituents of Concern represents an efficient yet effective method of assessing potential risks associated with mixtures of chemicals. A toxicity profile will be written for each of the selected Constituents of Concern. These profiles will summarize the important toxicological information concerning each chemical. Evaluation of the Constituents of Concern for the effects of potential exposures will also account for evaluation of potential risks posed by the other, less toxic chemicals detected.

The use of Constituents of Concern represents an efficient yet effective method of assessing potential risks associated with mixtures of chemicals. A toxicity profile will be written for each of the selected Constituents of Concern. These profiles will summarize the important toxicological information concerning each chemical. Evaluation of the Constituents of Concern for the effects of potential exposures will also account for evaluation of potential risks posed by the other, less toxic chemicals detected.

### 1.5.6 Migration Pathway Analysis

The objectives of this task are to identify site-specific chemical transport pathways and to characterize the media relevant to that transport. The findings will be used to estimate potential exposure of human receptors to site-related chemicals. Site reconnaissance will be conducted by risk evaluation personnel to better understand:

- o possible migration pathways;
- o current conditions of the site and surrounding area; and
- o topography, hydrology, and geology.

#### Characterize Critical Exposure Pathways

Site-related chemicals may possibly be contained in the surface soils. A number of potential migration pathways exist for off-site movement of these site-related materials. Off-site migration of chemical waste components may result from ground water movement, surface water runoff, and/or air transport of volatiles and fugitive dust. Compounds that are contained more deeply in the soil matrix may leach or may have leached into ground water, depending on such factors as the permeability and composition of the surrounding geologic strata. The aquifer(s) underlying the CIBA-GEIGY facility can potentially transport chemicals to off-site locations and potentially discharge into the Pawtuxet River, which flows into the Pawtuxet Cove.

Site-specific models will be developed to quantitatively characterize each migration pathway that may lead to exposure of a receptor. The results will provide input to exposure models in the identification and evaluation of critical exposure pathways.

### Media of Concern

The media potentially relevant to each migration pathway will be characterized for its significance at this site. The media to be considered for the CIBA-GEIGY facility will include:

- o ground water;
- o surface water, especially the Pawtuxet River;
- o soil on and surrounding the facility;
- o sediment of the Pawtuxet River; and
- o air.

During the preparation of the PHERE, the ground water will be characterized for:

- o aquifer classification by the State of Rhode Island;
- o aquifer quality and hydrogeological parameters;
- o aquifer recharge and discharge patterns;
- o aquifer usage patterns, present, and future;
- o location of actual and potential users of the aquifer; and
- o evaluation of the potential for discharge of ground water to surface water bodies.

Much of the information concerning the hydrogeology of the site and its surrounding region will be collected during Phase I and Phase II of the RCRA Facility Investigation.

Surface water bodies will be characterized for the following:

- o State of Rhode Island stream classification of streams feeding the Pawtuxet River, the Pawtuxet Cove, and outfalls of the Pawtuxet River;



- o water quality of the Pawtuxet River, upstream and downstream;
- o flow parameters of the Pawtuxet River and of outfalls of the Pawtuxet River;
- o uses of the Pawtuxet River and of outfalls of the Pawtuxet River; and
- o sewer lines, storm drains, and other utilities that may provide conduits for surface water discharges.

Initial review of site data suggests that the Pawtuxet River is the major surface water body of concern for the PHERE.

The sediment from this surface water body of concern will be chemically characterized both upstream and downstream of the site. Sediment transport potential due to storm events and normal river flow will be evaluated as a migration pathway for chemicals to move downstream.

The facility land and the land surrounding the facility will be characterized for:

- o soil characteristics and topography;
- o past, present, and future zoning; and
- o past, present, and potential future land use.

Air will be considered as a potential medium for chemical migration as the Order requires regulatory guideline comparisons, including the use of both state and federal air guidelines.

### 1.5.7 Exposure Scenario Characterization

The objective of this task is to define the appropriate potential human and environmental receptor populations. Potential exposures for all relevant pathways will be evaluated for human and environmental populations defined by the receptor survey. These potential exposures may result from:

- o direct inhalation of vapors and particulate-bound chemicals;
- o ingestion of or dermal contact with water, soil or sediments containing site-related chemicals; and
- o ingestion through the food chain.

#### Population Demographics

Identification of the potential human receptors requires knowledge of the regional demography. A demographic analysis of the region surrounding the CIBA-GEIGY facility, including the availability and use of surface and ground water resources, will be conducted. Current demographic records from federal, state, and local agencies will be consulted [including EPA's Graphical Exposure Modeling System (GEMS, 1989) census database], if available, to provide a projection of population changes since the 1980 census study.

In conducting the demographic analysis, special attention will be given to those areas that are hydrologically downgradient or "downwind" from the site. "Downwind" will be defined as the predominant downwind direction determined from the most recent, commercially available meteorological data applicable to the site. The size and distribution of off-site populations most likely to be exposed to ground water from the water-bearing system under the site will be estimated using the available demographic data. Similarly, populations that possibly may inhale site-related chemicals will be identified from census tract data. Consideration will also be given to dermal contact with soil or surface water and to exposures through the food chain.

### Location of Sensitive Populations

Sensitive populations are those considered to be at greater risk than the typical receptor. Sensitive receptor populations typically include children, the infirmed, and the elderly. The demographic survey will identify potential sensitive receptor locations such as schools, day care centers, hospitals, nursing homes, and senior citizen housing. At a minimum, the following specific receptor locations identified in the Order will be included in the consideration of sensitive populations:

- o Christopher Rhodes High School;
- o Aldrich Junior High School;
- o Park View Junior High School;
- o Fay Field;
- o Beechmont Recreation Field;
- o Roger Williams Park;
- o Sprague Playground;
- o Park Avenue Elderly Housing;
- o Cranston General Hospital;
- o Hall Manor Elderly Housing;
- o Scandinavian Nursing Home; and
- o Edgewood Highland, Norwood Avenue, and Beechmont Elementary Schools.

These areas will be evaluated for the potential for impact due to the possible release of chemicals from the CIBA-GEIGY facility. No analyses will be conducted for chemicals other than those that can be specifically related to CIBA-GEIGY and are of concern.

### Environmental Receptors

The approach to characterizing potential environmental receptors is discussed in Section 1.5.4.

#### **1.5.8 Exposure Assessment**

At each point of potential exposure to determine complete exposure pathway, the following potential exposure routes will be evaluated to determine if there is a complete exposure pathway:

- o inhalation of chemical vapors or particulates released into the air;
- o ingestion of chemical-containing ground water, surface water, soil, or sediment; and
- o dermal absorption of chemicals from contact with ground water, surface water, soil, or sediment.

A screening evaluation of all pathways will be made. Incomplete pathways and those where a low probability of exposure exists may be dropped from further consideration after consultation with and approval by EPA.

### Estimation of Exposure Point Concentrations

The identification and estimation of potential exposure point concentrations for all Constituents of Concern will be conducted employing health-protective assumptions for an average exposed individual (AEI) and a reasonable maximum exposed individual (RMEI) following the guidance given in the HHEM (EPA, 1989d). These exposure scenarios are discussed in detail later in the section entitled "Characterization of Exposure Scenarios." In this instance, "health-protective" means that the assumptions, data, and methodologies will be used which are reasonable but which will provide upper bounds on exposure point concentrations. Estimated exposure point concentrations will be identified for each of the following potential migration pathways when appropriate:

- o ground water;
- o surface water;
- o soil;
- o sediment; and
- o air.

The "average" exposure point concentrations for a SWMU will be assumed to equal the arithmetic or geometric averages of the media-specific exposure point chemical concentrations. The rationale for the use of arithmetic or geometric means will be discussed. EPA Region I guidance for risk assessment (EPA Region I, 1989) will be followed for deciding when to use the "hot spot" approach. Similarly, the "average" concentration will be used in the models for estimating the exposure point chemicals concentration for the AEI located in an area for which appropriate analytical data are not available. The exposure point chemical concentration for the RMEI will be assumed to be the maximum concentration encountered. The maximum concentration will be used in models for the estimation of exposure point concentrations for RMEI.

Some of the chemicals analyzed for in the samples may be below the detection limit. The following criteria will be used for estimating the exposure point concentration for that chemical in a defined SWMU. If the chemical is not detected in any of the samples from a medium at a SWMU, it will be assumed that the chemical is not present (i.e., the concentration is zero), and it will not be considered further in the risk analysis for that SWMU. If the chemical is measured at levels above the detection limit in one or more SWMU samples, but not in all of the samples, the concentration in those samples that are below the detection limit will be assigned a value which is one-half the detection limit for that SWMU. Chemicals below the detection limit in off-site samples will be handled in the same manner.

The exposure point concentration will be estimated using the previously described procedures. The exposure point concentrations described for on-site locations will represent the ambient concentration (background plus concentrations contributed by the facility). For off-site locations, exposure point concentrations of Constituents of Concern will be measured or modeled to estimate the contribution of the facility to ambient concentrations. Validation of dispersion models will be discussed as part of the PHERE. Background concentrations, generally considered to be concentrations of a chemical found in the sampled media at some point upgradient from the established release point, will be determined on a site-specific basis using predetermined background sampling locations. Those locations are discussed and described in Section 1.5.3.

The identification and estimation of potential exposure point concentrations will be conducted for each SWMU in the following manner:

- o select analytical data representative of actual or potential exposure point concentrations; and
- o estimate exposure point concentrations for current and potential future exposures by using the mean concentration for the AEI and the maximum concentration for the RMEI as representative concentrations in a given area; in addition, environmental fate will be discussed where appropriate.

Validated ground water and surface water modeling may be needed to provide exposure point concentrations. At least one numerical model and possibly several analytical models can be applied using existing site data. The purpose of the models should be to aid in estimating the current and future boundaries of a plume if one exists. Solute transport and receptor point concentrations will be predicted.

Soil and sediment exposure point concentrations will utilize actual on-site sampling data to represent exposure point concentrations. It is not expected that

modeling will be necessary for the calculation of the concentrations in soil or sediment.

If the air migration pathway proves to be a relevant and significant pathway, appropriate air dispersion modeling will be conducted using Region I EPA-approved methodology to provide an estimate of exposure point concentrations of the selected indicator chemicals.

### Environmental Fate of the Site-Related Chemicals

Many of the chemicals identified at the CIBA-GEIGY facility are known to undergo either anaerobic or aerobic biodegradation as well as photodegradation. The impact of degradation pathways and products will be quantitatively discussed in terms of the potential exposure point concentrations in the relevant media. Discussions will include:

- o the persistence of the indicator chemical in various media;
- o the potential for chemical degradation over time; and
- o the potential for concentration increase over time.

### Characterization of Exposure Scenarios

Potential risk to human receptors will be evaluated in the baseline risk assessment using both the AEI and RMEI in scenarios for current and future use of the CIBA-GEIGY site. Current use will be as described in Section 1.5.7 ("Population Demographics"), while future use will be assumed to be residential. The RMEI scenario will use the maximum current exposure at the site. The values used in this scenario will be selected so that the combination of all intake variables results in an estimate of the reasonable maximum exposure for that pathway. The AEI scenario will be representative of the "more likely to occur" exposure scenario based on site-specific assumptions. The values used in this scenario will be selected so that the estimated level of intake will be for an "average" individual. These exposure scenarios depend on:

- o migration pathways to the exposure point;
- o exposure duration at the exposure point;
- o exposure frequency at the exposure point;
- o media characterization (e.g., chemical concentration); and
- o receptor characterization (e.g., ingestion parameters).

A range of exposures will be estimated from the actual and estimated exposure point concentrations of the Constituents of Concern for the AEI and the RMEI. The appropriate values to be used in the two exposure scenarios will be taken from EPA Region I risk assessment guidance (EPA Region I, 1989), HHEM (EPA, 1989d), and Exposure Factors Handbook (EPA, 1989a).

#### Estimates of Potential Daily Intake

Estimates of potential daily intake will be made using actual or estimated exposure point concentrations combined with the various exposure scenarios described earlier in Section 1.5.8 ("Characterization of Exposure Scenarios"). Assumptions concerning body weight, breathing rate, ingestion rate, soil and dermal transfer rates, and other exposure-related parameters for the RMEI and the AEI will be taken from the HHEM (EPA, 1989d) and the EPA Exposures Factor Handbook (1989a). The assumptions will follow the guidelines set forth in the Order, the HHEM (EPA, 1989d), and EPA Region I Supplement Risk Assessment Guidance for the Superfund Program (1989f).

Intake estimates for environmental receptors will be specific once any relevant, sensitive, or endangered species are identified.

#### **1.5.9 Risk Characterization**

This section describes the methodology of characterizing noncarcinogenic (chronic, subchronic, and acute) health effects, the estimation of incremental



lifetime cancer risk, and environmental impacts due to potential exposure to the site-related chemicals.

As requested in the Order, exposure point concentrations for each site-related chemical at each potential exposure point will be compared to:

- o applicable and relevant exposure standards;
- o health and/or risk-based guidelines or policies (where such guidelines or policies exist); and
- o values will be proposed CIBA-GEIGY after consultation with EPA in the case that no such standards or guidelines exist for a site-related chemical.

The total risk for a receptor will be estimated, if appropriate, using the exposure profile defined as part of the risk assessment. Both threshold and nonthreshold (carcinogenic) human health risks will be characterized for each site-related chemical.

#### Potential Human Health Impacts

**Excess Carcinogenic Risk Estimates.** Site-related chemicals ranked in Class A, B<sub>1</sub>, B<sub>2</sub>, or C as defined in IRIS or HEAST will be used to estimate incremental lifetime cancer risks based on the receptor's exposure profile. The estimated incremental lifetime cancer risk from individual chemicals on plausible exposure scenarios will be compared relative to the "background" cancer incidence. If the estimated carcinogenic risk is due mainly to exposure to Class C carcinogens, this subject will be addressed in Section 1.5.11 ("Uncertainty Analysis").

**Noncarcinogenic Health Effects.** Noncarcinogenic health effects will be characterized by estimating hazard indices (HIs).

HI = Intake at exposure point/reference dose

An initial screening will be conducted by including all site-related Constituents of Concern in one HI. In general, it will be more appropriate to estimate an additive HI group of chemicals with common mechanisms of action or common toxicological endpoints. However, for this assessment, the approach adopted will be to use a total HI of one as the decision point for looking at chemicals on an individual basis. Based on the decision point, HIs may be calculated for individual chemicals or appropriate chemical mixtures to determine if any might result in a long-term human health risk.

### Potential Environmental Impact

This evaluation will be performed using the guidelines outlined in EPA Region 1 Supplement (EPA 1989f) concerning ecological risk assessments. The potential for adverse effects to the environment will be estimated for the various media and related receptors using the various exposure point concentrations. The bioassays described in Section 1.1.2 will be used in evaluating the potential for environmental impact on aquatic populations due to the potential release of chemicals from the CIBA-GEIGY facility. If the bioassay results indicate a potential impact may exist, further bioassays of appropriate species may be required. The development of further protocols to assess potential impacts upon aquatic life will be done in consultation with EPA Region 1.

Site reconnaissance will be done to evaluate the impact upon on-site and adjacent plant communities. Significant wildlife habitats and possible potential terrestrial environmental receptors will be identified during this reconnaissance. Exposure point concentrations will be used to estimate the potential intake by environmental receptors. The potential for adverse impact upon terrestrial receptors will be evaluated by comparing the estimated intake with published no-observable-adverse-effect level (NOAEL) and lowest-observable-adverse-effect level (LOAEL) values or other toxicological values.

### Standards Comparison

A comparison of the exposure concentrations will be made to the appropriate and applicable standards for each Media of Concern. The following comparisons will be conducted:

- o de Minimus and appropriate excess carcinogenic risk levels;
- o maximum contaminant levels (MCLs) for water quality;
- o National Ambient Air Quality Standards;
- o Drinking Water Quality Standards;
- o National Academy of Science Advisories;
- o World Health Ambient Air Standards;
- o Rhode Island Ambient Air Standards;
- o National Water Quality Criteria;
- o Rhode Island Water Quality Standards; and
- o values proposed by CIBA-GEIGY after consultation with EPA in the case that no such standards or guidelines exist.

The proposed guidelines will be developed following the procedures given in the HHEM (EPA, 1989d). For noncarcinogenic chemicals, an appropriate NOAEL will be identified based on review of the available literature. The NOAEL is the highest concentration in an experiment at which there are no statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control; some effects may be produced at the LOAEL, but they are not considered to be adverse, nor precursors to specific adverse effects. In the absence of the NOAEL, the LOAEL may be used. The proposed guideline is estimated by dividing the NOAEL (or LOAEL) by an uncertainty factor. The uncertainty factors generally consist of multiples of 10 (although values less than 10 are sometimes used), with each factor representing a specific area of uncertainty inherent in the extrapolation from the available data. The uncertainty factor used will be selected using the guidance given in the HHEM (EPA, 1989d).

Slope factors will be estimated for those chemicals that are known or probable human carcinogens. The slope factor will be estimated from appropriate data using the protocol given in the HHEM (EPA, 1989d).

#### **1.5.10 Conclusions and Recommendations**

Implications of the estimated risks associated with current and potential future exposures will be presented. In drawing conclusions, the following (at a minimum) will be noted:

- o any exposure point concentration which exceeds corresponding standards, guidelines, or policies;
- o the need, if any, for reducing exposure point concentrations and the amount of reduction;
- o an estimation of the potential for human health impact;
- o an estimation of the potential for environmental impact; and
- o recommended Media Protection Standards (if necessary).

#### **1.5.11 Uncertainty Analysis**

Uncertainties associated with the estimates of risk will at least be addressed qualitatively to provide information on the level of confidence associated with the approaches used. Potential human health risks posed by a defined set of circumstances may be evaluated quantitatively. The precision of these estimates is limited by the size and quality of the data base. Often, these limitations can be overcome by defining a range of extremes. Due to the use of these extremes, there are varying degrees of uncertainty associated with estimating the potential risks from chemical exposure. These uncertainties will be compensated for in the risk assessment by making health-protective assumptions.

Specifically, uncertainty associated with the following areas will be addressed:

- o receptor populations;
- o ground water data base;
- o exposure estimates;
- o toxicological data and risk characterization; and
- o complex interactions of uncertainty elements.

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STRATEGIC PLAN

SECTION 2  
MEDIA PROTECTION STANDARDS WORK PLAN

---

2.1 INTRODUCTION

Concurrent with the submission of the RCRA Facility Investigation Report, proposed Media Protection Standards (MPS) for selected chemicals potentially released from any of the SWMUs and/or Areas of Concern will be submitted to EPA in accordance with the Order. The MPS will be used as guidelines for clean-up standards to be considered in the CMS. Therefore, MPS will be recommended only in the case that any site-related chemicals exceed media-specific state, federal, and/or proposed guidelines, or exceed measured local background chemical concentrations.

2.2 OBJECTIVES

The MPS will be used to establish guidelines for measuring the necessity for and/or the degree of protection afforded by the corrective measures considered in the CMS.

2.3 STRATEGY

The MPS will consist of applicable or relevant and appropriate state and/or federal requirements (ARAR). The ARARs include:

- o MCLs for water quality;
- o National Ambient Air Quality Standards;
- o Drinking Water Quality Standards;
- o National Academy of Science Advisories;

- o World Health Ambient Air Standards;
- o Rhode Island Ambient Air Standards;
- o National Water Quality Criteria; and
- o Rhode Island Water Quality Standards.

MPS will be developed for those chemicals in each Media of Concern which do not have an appropriate established criteria or for which an Alternate Concentration Limit is proposed. The development of these MPS will follow the guidance given in the EPA Supplemental Risk Assessment Guidance for the Superfund Program (Draft), EPA Region I, May 1989, and other documents if necessary.

## 2.4 JUSTIFICATION

These work plans incorporate applicable approaches for the development of MPS as presented in the following documents:

- o Supplemental Risk Assessment Guidance for the Superfund Program (Draft), EPA Region I, May 1989.
- o Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual (HHEM) (EPA, 1989d);
- o Administrative Order on Consent (Order) No. I-88-1088, issued to CIBA-GEIGY (1989).

## 2.5 APPROACH TO MEDIA PROTECTION STANDARDS DEVELOPMENT

MPS will be proposed for each site-related chemical measured in the environmental media. MPS will potentially be defined for each of the following media:

- o air;
- o ground water;
- o surface water; and
- o soil and sediment.

The description of each MPS will include:

- o data supporting the limits specified;
- o locations at which the MPS shall be met; and
- o estimated time frame for achieving the specified limits.

The guidelines set forth in the Order will be followed for defining the MPS for each chemical. These are:

- o The inclusion of data will justify and support the specified limits.
- o The specified limits will not exceed background levels or limits specified in the Order.
- o Proposed Alternate Concentration Limits (ACLs) for chemicals will meet the human health-protective requirements established in the Order.
- o MPS will be developed for all chemicals having no established criteria.

The proposed ACLs and the MPS for chemicals which do not have ARARs, will be estimated using the acceptable chronic intake levels described previously in Section 1.5.8 and the exposure scenarios previously described in Section 1.5.7. The proposed ACLs will be estimated based on the highest acceptable concentration that may be present in an environmental medium but will not cause adverse health effects in a chronically exposed individual, as defined in the previously described exposure scenarios (Section 1.5.5). These concentrations may exist in the environment and the daily potential intake for an individual will not exceed the appropriate and applicable health protective standards for that chemical as defined in Section 1.5.8.



The additive risk of chemicals in a multi-media exposure will be summed. The appropriate MPS for chemicals that present a potential additive health risk will be addressed on a case-by-case basis. Carcinogenic effects for the same receptor will be summed for carcinogens of Classes A, B<sub>1</sub>, B<sub>2</sub>, and C, using EPA-approved cancer potency factors.

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**SECTION 3  
CORRECTIVE MEASURES RISK EVALUATION WORK PLAN**

---

**3.1 INTRODUCTION**

If necessary, corrective measure alternatives will be proposed in the CMS. It is necessary to evaluate the human health and environmental impacts of each corrective measure proposed in the CMS. The PHERE will quantitatively describe current site conditions from a risk perspective. The health and environmental risk models used in the PHERE will provide the basis for evaluating the proposed corrective measures.

**3.2 OBJECTIVES**

The evaluation of the corrective measures will assess each corrective measure in terms of the extent to which it migrates, short- and long-term potential exposure to any residual chemical concentrations and protects human health both during and after implementation of the corrective measure. The evaluation will also include the assessment of environmental impacts of each corrective measure.

**3.3 STRATEGY**

The information collected about chemical releases, routes of exposure, human and environmental exposure points, and the MPS will be used as input for further development of the proposed corrective measures. Each corrective measure will be compared to the MPS in accordance with the EPA risk assessment guidance applying the methodology and site-specific models employed in the PHERE.

### 3.4 JUSTIFICATION

The assessment of the proposed corrective measures will follow the guidance given in the following documents:

- o The Risk Assessment Guidance for Superfund, Vol I: Human Health Evaluation Manual (HHEM) (EPA, 1989d);
- o The Risk Assessment Guidance for Superfund, Vol. I: Environmental Evaluation Manual (EPA, 1989e);
- o EPA Region I Supplemental Risk Assessment Guidance for the Superfund Program, (EPA, 1989f);
- o Guidance for Establishing Target Cleanup Levels for Soils at Hazardous Waste Sites (EPA, 1988a); and
- o Methods for Evaluating the Attainment of Cleanup Standards Vol. I: Soils and Solid Media (EPA, 1989c)
- o The Administrative Order on Consent (Order) No. i-88-1088, issued to CIBA-GEIGY (1989).

### 3.5 CORRECTIVE MEASURE ALTERNATIVES EVALUATION

The scope of the corrective measure alternatives evaluation will depend on the results of the RCRA Facility Investigation, the PHERE, and the initial alternatives screening. Quantitative assessment of corrective measures for these areas will use as much site-specific information as possible. The specific

components for each of the SWMUs and Areas of Concern for which corrective measures are to be considered by the alternative evaluation are as follows:

- o exposure assessment; and
- o risk-reduction effectiveness:
  - Remediation that satisfies existing MPS
  - Remediation that exceeds existing MPS
  - Remediation that does not meet existing MPS but may nevertheless constitute a satisfactory approach to management of the site.

### **3.5.1 Corrective Measure Alternatives Evaluation — Human Health**

The corrective measure alternatives evaluation for human health effects will assess the potential for impact at the following locations under current as well as future exposure scenarios:

- o Christopher Rhodes School;
- o Aldrich Junior High School;
- o Park View Junior High School;
- o Fay Field;
- o Beechmont Recreation Field;
- o Roger Williams Park;
- o Sprague Playground;
- o Park Avenue Elderly Housing;
- o Cranston General Hospital;
- o Hall Manor Elderly Housing;
- o Scandinavian Nursing Home; and
- o Edgewood Highland, Norwood Avenue, and Beechmont Elementary Schools.

### 3.5.2 Corrective Measure Alternatives Evaluation — Environmental

The environmental assessment performed in the PHERE will serve as a baseline environmental assessment for the corrective measure alternatives evaluation. The alternative evaluation of the potential environmental effects will help determine which corrective measures will achieve adequate protection where environmental quality is potentially threatened at the CIBA-GEIGY facility.

For each corrective measure, the short- and long-term beneficial and adverse effects will be assessed, including potential cross-media impacts. The level of detail in the environmental assessment of each corrective measure will depend on the complexity of the specific area and the considered alternative. The appropriate level of detail will be adequate to meaningfully compare the expected benefits of different corrective measures. Also, the approach will be adequate to determine the extent of impacts of potential remedial operations. Guidelines presented in the Region I supplement for environmental assessments (EPA, 1989f) will be used in conducting the environmental assessments of the corrective measures.

Factors generally considered in determining the level of detail include:

- o the effects of environmentally sensitive areas;
- o violation of environmental standards;
- o short- and long-term effects; and
- o irreversible commitments of resources (e.g., availability of land for future use).

The following areas will be evaluated for environmental impact due to corrective measure alternatives:

- o Roger Williams Park;
- o any parks or wetlands adjacent to the facility; and

- o Pawtuxet River and any connecting downgradient surface waters.

Findings will be presented so that environmental effects of corrective measure alternatives can be compared.

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STRATEGIC PLAN

SECTION 4  
REFERENCES

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**VOLUME 1 - CHAPTER 2**  
**SECTION 5**  
**PROJECT MANAGEMENT PLAN**

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This section presents the Project Management Plan for the RCRA Facility Investigation at the CIBA-GEIGY facility in Cranston, Rhode Island.

**5.1 INTRODUCTION**

The Project Management Plan describes the organization of the project and identifies the tasks to be accomplished during the RCRA Facility Investigation. These tasks must be managed, not only to ensure that the work is completed on time, but also to ensure that accurate information is provided for designing and conducting site remediation. The Project Management Plan will describe the specific tasks to be accomplished in each of the work phases covered by the Order and also will show the tasks graphically. The Order specifies a series of deliverable documents; the contents and submission schedule for these documents will be described here as well.

**5.2 PROJECT ORGANIZATION**

The organization of the RCRA Facility Investigation project centers on a Project Coordinator (a CIBA-GEIGY employee) who will represent CIBA-GEIGY's commitment to meeting the objectives of the RFI. The Project Coordinator will be responsible for the interaction between CIBA-GEIGY's environmental consultants and the USEPA, as well as for overseeing implementation of all of the work identified in the Order. The Project Coordinator will participate in, and will provide CIBA-GEIGY's input for, all decisions.

CIBA-GEIGY will use environmental consultants to assist in conducting the Facility Investigation. These consultants will conduct the field investigation, evaluate the analytical data, perform the Public Health and Environmental Risk Evaluation (PHERE), propose the Media Protection Standards, and prepare the Corrective Measures Study. The major organizational entities and their interrelationships in the project are shown on Figure 5-1.

### **5.3 PHASE I INVESTIGATION**

Management of the Phase I investigation entails field work in Phases IA and IB, Phase I progress reports, and the Phase I Interim Report.

#### **5.3.1 Field Work in Phase IA and Phase IB**

Phase I tasks include field investigations, sampling, and monitoring of selected parameters in order to quantify what will be required of the remediation plan. The tasks in Phase I are shown on Figure 5-2 (Gantt chart) which also shows their timing and interdependency. The field work will be completed within seven months after the USEPA's written approval of the RFI Proposal.

Solid Waste Management Units (SWMUs), Areas of Concern (AOCs), and Additional Areas of Investigation (AAOIs) have been identified. These areas will be gridded to position sampling locations precisely. Borings, monitoring wells, piezometers, and test pits will be installed; maps showing the locations of all monitoring wells, borings, test pits, and other sampling points will be prepared by a professional land surveyor. Borings and test pits will be installed to investigate the subsurface geologic and hydrogeologic strata. Geophysical surveys will identify subsurface discontinuities.

Two sampling rounds for all Media of Concern will be conducted at the on-site SWMUs, AOCs, and AAOIs required by the Order. At least one round of sampling will be conducted off-site to cover AOCs and Media of Concern required

by the Order. Sampling and monitoring will continue during Phase II to establish long-term trends and patterns.

Indicator chemicals that reflect the existing contamination of the site will be selected. Monitoring the measured reduction in the presence of these chemicals will be the basis for determining the success of the remediation efforts.

As indicated on Figure 5-2, Phase I has been divided into Phase IA and Phase IB. Phase IA work is the physical characterization of the facility (Tasks 2.1 through 2.4). A Phase IA report (Task 4) will be submitted to the USEPA for review seven weeks after the physical characterization work ends. The release characterization described in the RCRA Facility Investigation (RFI) Proposal will be revised (as needed) based on information from the physical characterization. All proposed changes will be approved by the USEPA prior to implementation. It is understood that the ten-month Phase I schedule for field work and completion of the Phase I Interim Report does not include the time during which the USEPA reviews the Phase IA report.

### 5.3.2 Phase I Progress Reports

Monthly (summary) progress reports will be submitted to the USEPA by the tenth calendar day of the month following the subject month. The progress reports will describe the tasks completed during the subject month, and will include:

- o sampling data -- the dates, locations, types, and number of samples taken;
- o laboratory data -- the dates the samples were sent to and/or returned from the laboratory, as well as the analytical test results;

- o other data -- the results of analyses and calculations performed by the environmental consultants;
- o planned work -- the tasks (both in the field and in the office) planned for the next two months, along with specific scheduled dates; and
- o problems and planned resolutions -- the descriptions of any problems encountered or anticipated, and the detailed steps that are planned to overcome the problems.

The Phase I field work (through Task 5.12) will be completed within seven months of the acceptance of the RFI Proposal by the USEPA, exclusive of time required by the USEPA to review the Phase IA report.

### **5.3.3 Phase I Interim Report**

After completing the Phase I field work, all the data collected will be analyzed and reviewed. An Interim Report (Task 7) will be submitted to the USEPA within 13 weeks after completing the Phase I field work. The Interim Report will summarize all the work in, and the results of, Phase I including:

- o a site plan map showing all sampling locations;
- o the results of the geophysical surveys conducted to identify paths that would facilitate the underground migration of contaminants;
- o text and tables describing and quantifying the results of the on-site and off-site Phase I sampling;
- o a definition of subsurface geologic and hydrogeologic features and strata based on the monitoring well, test boring, and test pit information;

- o identification of the indicator chemicals that will be monitored to ascertain the effectiveness of subsequent remediation efforts;
- o a statement about any additional Media of Concern that have been identified by the Phase I work program (the consequences of which will be addressed in the Phase II Proposal);
- o a statement about any additional SWMUs or AOCs that have been identified (the consequences of which will be addressed in the Phase II Proposal); and
- o a statement about any releases of contaminants from the SWMUs or AOCs that require the immediate implementation of interim protective measures.

#### 5.4 PHASE II INVESTIGATION

Management of the Phase II investigation entails the Phase II Proposal and Phase II field work.

##### 5.4.1 Phase II Proposal

Analysis of the Phase I data also will be used to develop the Phase II Proposal. The Phase II Proposal will be submitted to the USEPA at the same time as the Phase I Interim Report (13 weeks after the completion of Phase I field work), and will incorporate any additional data requirements that have been identified in the following areas:

- o geophysical surveys;
- o monitoring wells; and
- o borings and test pits.

The Phase II Proposal will contain a minimum of two sampling rounds for all media. In addition, the site plan map showing the location of all samples, monitoring wells, borings, and test pits will be updated to show the locations of the field work proposed for Phase II.

If the Phase I Interim Report identifies additional Media of Concern, SWMUs, or AOCs, then the Phase II Proposal also will describe the additional field measurements needed to evaluate the new potential hazards. The Phase II Proposal will show how all of the field work will be integrated to allow completion of the Phase II field program within eight months. However, CIBA-GEIGY and its environmental consultants may find that the work needed to evaluate any additional Media of Concern, SWMUs, or AOCs identified in Phase I cannot be accomplished in eight months. If so, they will recommend a course of action to accomplish the additional work required with the least delay.

If serious hazards are found in Phase I as the consequence of releases from any of the SWMUs or AOCs, CIBA-GEIGY and its environmental consultants will recommend to the USEPA the interim protective measures that are required.

The Phase II Proposal also will describe the analyses necessary to propose Media Protection Standards for all of the hazardous materials and constituents found to have been released from the SWMUs or AOCs.

#### **5.4.2 Phase II Field Work**

Phase II field work will be completed within eight months after receiving approval of the Phase II Proposal from the USEPA.

## **5.5 RFI REPORT**

The Phase I Interim Report will be modified and/or amplified (as needed) to reflect the findings of the Phase II field work, and will become the final RFI Report. The final RFI Report will be delivered to the USEPA within 13 weeks after completing the Phase II field work.

## **5.6 PROPOSED MEDIA PROTECTION STANDARDS**

The proposed Media Protection Standards will be submitted to the USEPA at the same time as the final RFI Report. Media Protection Standards specify the maximum levels of contaminants, by compound, that may remain in the various media after remediation. The report will present data justifying the standards, will locate where they will be met, and will describe the duration of the remediation necessary to achieve them. The minimum standards for ground water, soil, surface water, and sediment specified in the Order will be satisfied.

## **5.7 CORRECTIVE MEASURES STUDY PROPOSAL (PHASE III)**

Following USEPA acceptance of the proposed Media Protection Standards, CIBA-GEIGY and its environmental consultants will prepare a Corrective Measures Study (CMS) Proposal. The CMS Proposal will identify and recommend corrective measures for achieving the Media Protection Standards, and will be delivered to the USEPA within seven weeks after approval of the Media Protection Standards.

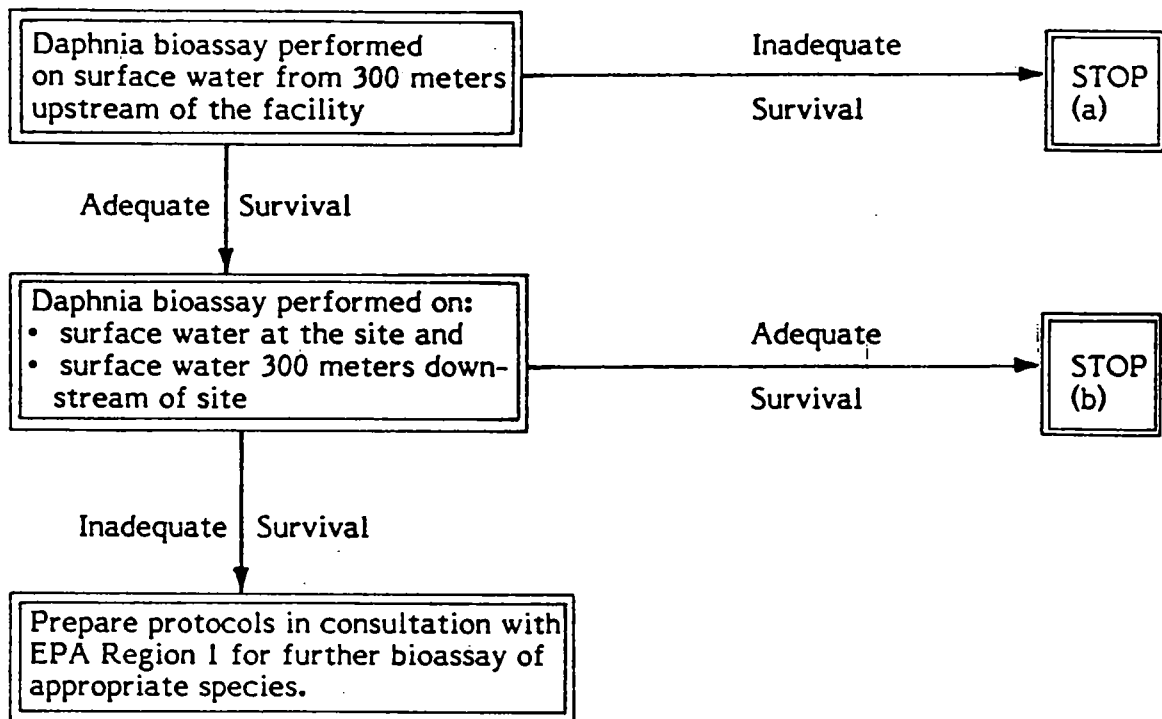
## **5.8 CORRECTIVE MEASURES STUDY REPORT (PHASE IV)**

The more detailed Corrective Measures Study Report will be submitted to the USEPA within fifteen weeks after approval of the CMS Proposal.

This section has presented the Project Management Plan for the RCRA Facility Investigation, including the project organization, the specific tasks that will be accomplished in each of the work phases, and the schedule for completing these tasks. This Project Management Plan, together with the PHERE, MPS, and Corrective Measures Risk Evaluation work plans, permits defining the overall Facility Investigation Work Plan (which is presented in the next chapter).



## **Figures**



- (a) Testing to stop at this point because the results will indicate that background surface water quality, upstream from the facility, is inadequate for the survival of the test species. Further testing of downstream surface water would not provide additional information concerning the possible impact of potential chemical releases from the facility.
- (b) Testing to stop at this point because the results will indicate that the potential for adverse impacts due to possible chemical releases from the facility is unlikely.

Figure 1-1. Tiered Approach For Bioassay

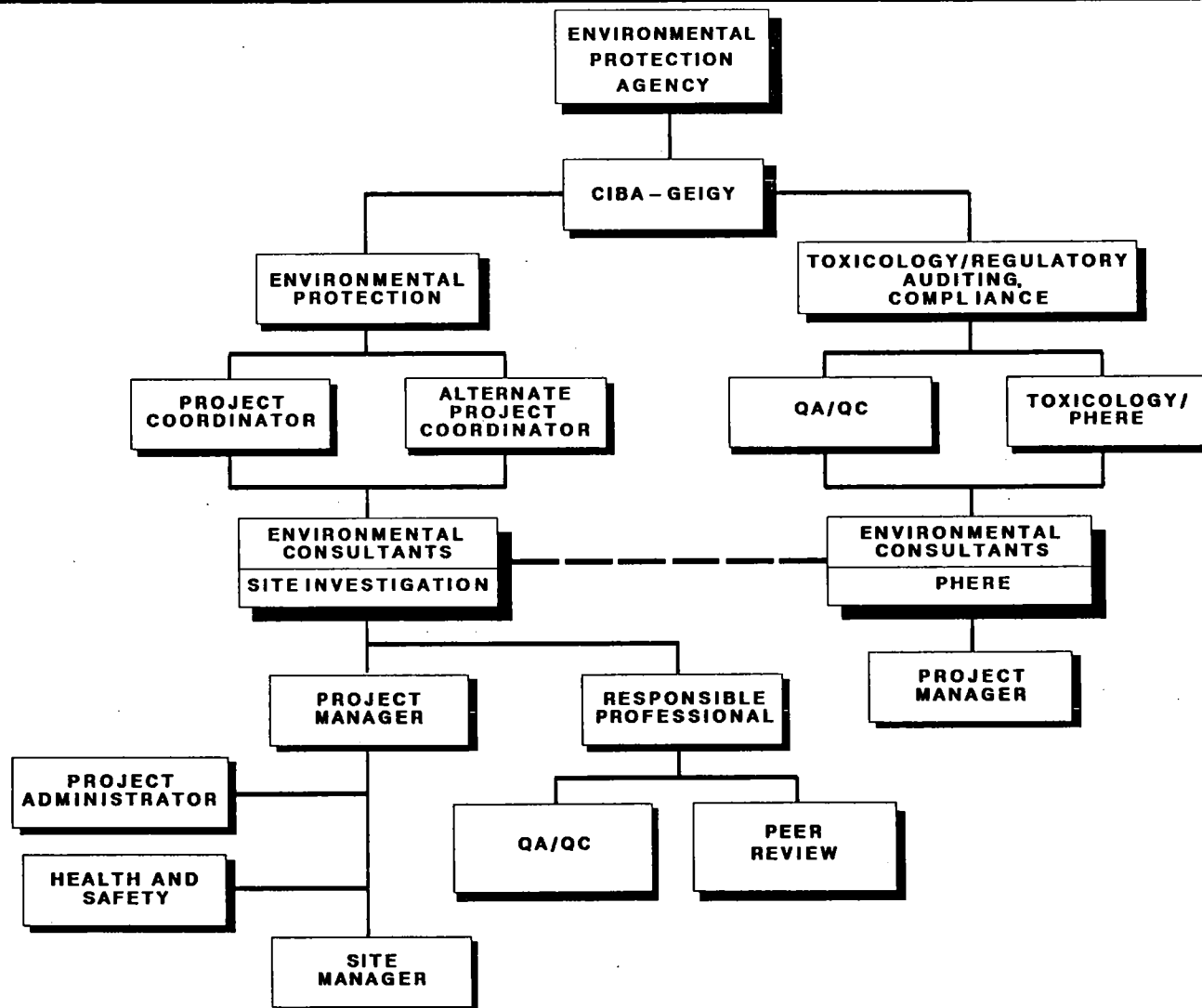
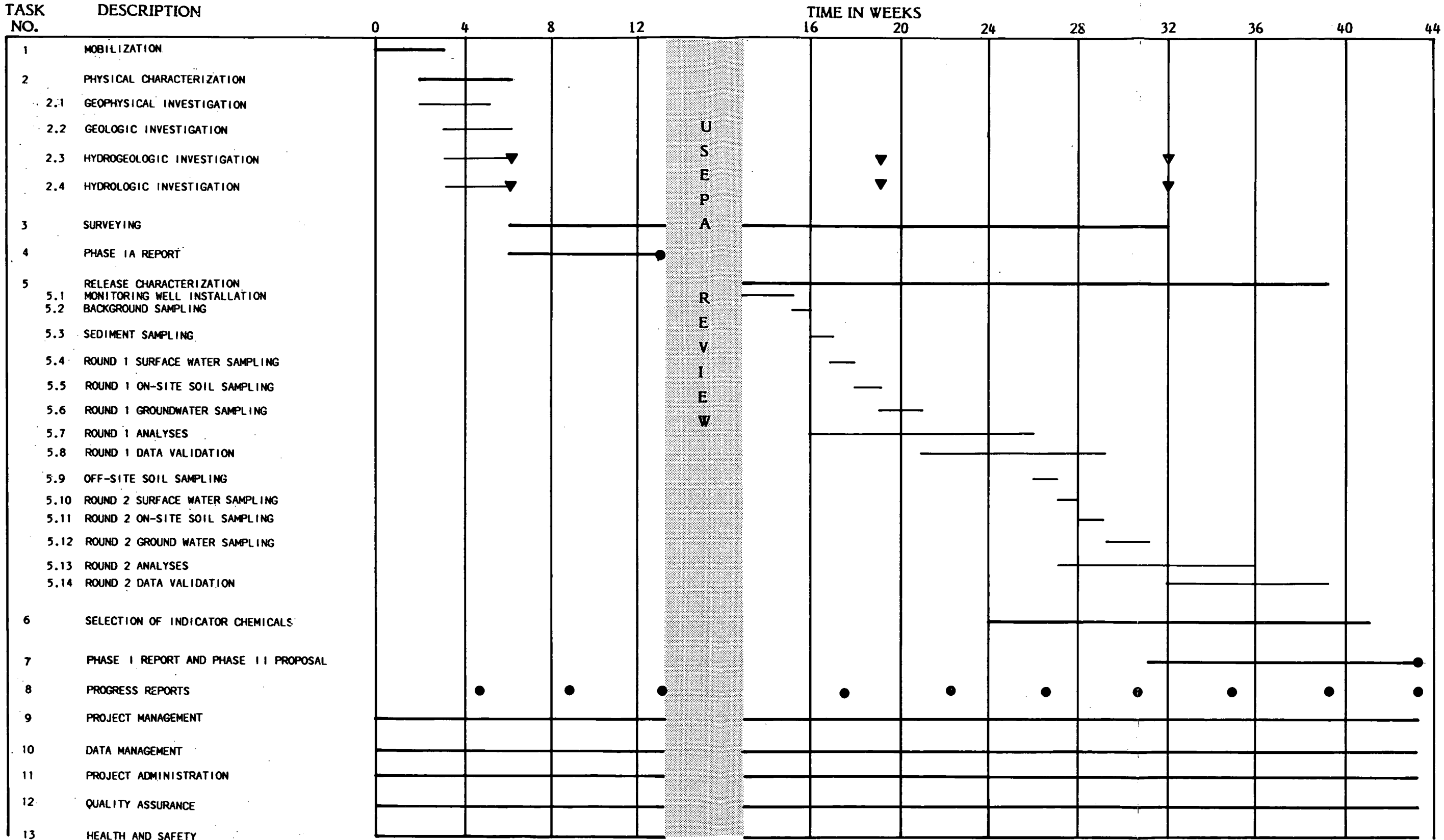


FIGURE 5-1

PROJECT ORGANIZATION CHART



Legend:

▼ Indicates Quarterly Event

● Indicates Deliverables

PHASE I SCHEDULE  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

**WOODWARD - CLYDE CONSULTANTS**

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

DR BY	CJM	SCALE	NONE	PROJ NO	87X4660
CK'D BY	MAA	DATE	16 MAR 1990	FIG NO	5 - 2

## **Chapter Three**

VOLUME 1 - CHAPTER 3  
FACILITY INVESTIGATION WORK PLAN

SECTION 1  
INTRODUCTION

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The Current Assessment Summary Report (Chapter 1) summarized the facility's history, identified the Conditions of Concern, and made recommendations for further study. The strategies for meeting the objectives of the RFI were presented in Chapter 2, which included Public Health and Environmental Risk Evaluation (PHERE), Media Protection Standards (MPS), and the Corrective Measures Risk Evaluation work plans, as well as the Project Management Plan.

This chapter -- the Facility Investigation Work Plan -- summarizes the work that will be performed in the RCRA Facility Investigation. It has these main sections:

- o Preliminary Investigation of Corrective Measures (Section 2) - identifies potential corrective measures that may be used to contain, treat, remedy, or dispose of the contamination resulting from releases of hazardous waste (or hazardous constituents) from the SWMUs or AOCs identified in the Order.
- o Physical Site Characterization Study (Phase IA) (Section 3) - describes the investigations that will be performed to characterize the facility's physical environment.
- o Release Characterization Investigation (Phase IB) (Section 4) - presents the scope of work that will be performed to verify suspected releases and assess the nature and extent of contamination resulting from past facility releases.

- o Source Characterization (Section 5) - describes the scope of work that will be performed for characterizing both the wastes (or hazardous constituents) and the units (SWMUs and AOCs) from which suspected releases may have occurred.
- o Preliminary Phase II Proposal (Section 6) - presents a preliminary view of the scope of work for Phase II.

**VOLUME I - CHAPTER 3**  
**FACILITY INVESTIGATION WORK PLAN**  
**SECTION 2**  
**PRELIMINARY INVESTIGATION OF CORRECTIVE MEASURES**

---

**2.1 INTRODUCTION**

This section of the Facility Investigation Work Plan presents the Preliminary Investigation of Corrective Measures. The Order requires that the RFI proposal identify the potential corrective measure technologies that may be used to contain, treat, remedy, and/or dispose of the contamination resulting from the release of hazardous waste and/or hazardous constituents from the SWMUs or other Areas of Concern (AOCs) listed in Chapter 1 - Current Assessment Summary Report (Section 5). The Current Assessment Summary Report summarized all prior investigations and identified field data that need to be collected during implementation of the RFI. Additional data needs are identified in this section to facilitate the technical evaluation and final selection of corrective measures (e.g., compatibility of waste and construction materials, information to evaluate effectiveness, and treatability of wastes).

Potential corrective measures and technologies will be screened for their ability to achieve the Media Protection Standards (which will be set by the USEPA for the facility). The tasks are to identify, develop, and justify the selection of potential corrective measures. Figure 2-1 illustrates the general progression for alternative development. CIBA-GEIGY will follow this logic to evaluate data needs periodically as the RFI progresses. Figure 2-2 illustrates how data collected in Phase I will be evaluated to determine the need for treatability investigations or additional data



collection for treatability purposes during Phase II. "Data needs" as contained on these flowcharts have been initially evaluated and are discussed in Section 2.5. It is recognized that data collection must meet changing requirements as the development of alternatives proceeds.

## 2.2 OBJECTIVES

This investigation will identify the data needed to facilitate the development, evaluation, and selection of corrective measures that will achieve the Media Protection Standards. These corrective measures will be designed to address human health and environmental hazards by reducing the toxicity or mobility through containment, treatment, removal, or reduction of Constituents of Concern.

The general objectives for corrective measures include:

- o protection of human health and the environment;
- o attainment of Media Protection Standards as determined by the procedure specified in Section VII of the Order;
- o control of the sources of releases so as to reduce or eliminate (to the maximum extent practicable) further releases that may pose a threat to human health and the environment; and
- o compliance with standards for management of wastes under the RCRA.

These objectives reflect the major technical components of corrective measures, cleanup of releases, control of hazard sources, and management of wastes generated by remedial activities. Because of the diversity of media at different locations, consideration will be given to evaluating different corrective measures at different locations.

### 2.3 STRATEGY

Fencing has been installed as an institutional control measure to restrict access by the general public. In addition, hydroseeding of the demolition areas was completed to retard surface runoff and reduce dust.

Previous studies, both the Facility Assessment and the Preliminary Investigation, have indicated that ground water quality within the Production Area has been impacted by operations. Some residual soil contamination may be associated with past operations and may warrant further evaluation.

Because decommissioning and demolition of site facilities included removal of any hazardous materials or hazardous waste material, no hazardous waste is believed to be present on-site at this time other than what has been identified as contamination in the various media. Preliminary Investigation of Corrective Measures analysis will evaluate residuals from past activities and the possible pathways and receptors of those residuals.

Alternative corrective measures will be compared on long-term reliability and effectiveness, reduction of toxicity, mobility or volume of wastes, short-term reliability and effectiveness, implementability, performance, safety, community acceptance, and risk

reduction. The Public Health and Environmental Risk Evaluation (PHERE) and subsequent Media Protection Standards will establish the objectives for the corrective measures.

## 2.4 JUSTIFICATION

This Preliminary Investigation of Corrective Measures is based primarily on the data presented in Volume 1 - Current Assessment Summary Report (Chapter 1). Those data indicated that some Constituents of Concern (volatile organic compounds - VOCs - and metals) are present in groundwater and soil in the southern section of the Production Area. Within the Waste Water Treatment Area, VOCs and metals were observed in ground water and soil. Within the Warwick Area, VOCs and metals were observed in soil samples. Pesticides, VOCs, and polynuclear aromatic hydrocarbons - PAHs-, were observed both in off-site soil samples and in sediment samples from the Pawtuxet River.

Media Protection Standards will be proposed for USEPA approval, and will determine the scope of the Corrective Measures Study. The Media Protection Standards are conservative -- they do not necessarily indicate a defined risk. The Constituents of Concern identified here represent a preliminary evaluation by CIBA-GEIGY. The final determination regarding Constituents of Concern, indicator chemicals, and human health and environmental risk concerns (i.e. site conditions that need to be considered for corrective measures) will be made as part of the PHERE and establishment of Media Protection Standards. Note that all of the Constituents of Concern may not be attributable to past operations at the facility -- some of the constituents detected in the

Off-Site Area and in sediment from the Pawtuxet River are believed to be from industrial and/or non-industrial activity unrelated to CIBA-GEIGY.

## 2.5 TECHNOLOGIES FOR CORRECTIVE MEASURES

Tables 2-1 through 2-4 list the candidate corrective measures and technology types for each of the four Media of Concern (i.e., groundwater, soil, surface water, and sediment). It is not yet possible to eliminate any candidate measure or technology based on the preliminary data or the site conditions. If the PHERE determines that facility-related contamination may pose a threat, then corrective measures will be evaluated for those areas and impacted media.

At this time, not enough information exists to determine if treatability investigations are necessary. Therefore, no treatability investigations, other than collection of analytical, physical and hydraulic data, are proposed in Phase I. Decisions on the need for treatability investigations will be made at the end of Phase I and proposed as part of Phase II. Decisions about whether bench or pilot scale studies are appropriate are based on many factors.

Bench scale treatability studies are usually conducted for the following reasons:

- o as proof of concept - e.g., will the process work on the mixture; new process development; demonstration of ability to work at conditions well beyond those previously documented;
- o to obtain new data not previously needed; and

- o to demonstrate separation, recovery, or destruction efficiency.

Pilot scale (beyond bench) studies are usually conducted for the following types of reasons:

- o to demonstrate operability over "long" periods of time;
- o to confirm economics - e.g. maintenance, heat requirements, etc.
- o to demonstrate that permit requirements can be met for a variety of feeds over a "long" period of time; and
- o to provide for an intermediate confirming step between bench and full scale operation.

In general, bench or pilot scale work can be omitted when the confidence level is high that the important design and operating parameters can be met. Process engineers often make this decision using some type of sensitivity analysis -- i.e., how well are the key parameters known and understood, what is the possible range of variation. If the design can easily or with minimal changes (which can be designed for in advance) meet the needed performance standards over the expected range of variables, treatability investigations may not be required. The decision is a judgment to be made after a sensitivity analysis has been done, and assessing the tradeoffs of spending the time and money on treatability studies versus the costs of being wrong.

The following sections provide discussions considering candidate corrective measures and associated technology types on a preliminary basis. It describes some of

the additional data requirements for developing, evaluating and selecting corrective measures. The data requirements are discussed under three categories (as appropriate to the media): hydrogeologic criteria, analytical criteria, and pilot scale and bench testing criteria. The rest of the Facility Investigation Work Plan (Volume 1, Chapter 3, Sections 3, 4, and 5) has been developed to provide data that will fulfill these requirements.

### 2.5.1 Ground Water

#### Technology Types

Table 2-1 lists the types of technologies that may be used for groundwater remediation. At this time, containment actions and collection/treatment options are probably viable. The technology types appropriate to these actions are:

- o vertical barriers;
- o groundwater collection/pumping;
- o physical treatment;
- o chemical treatment;
- o discharge to the publically owned treatment works (POTW);
- o discharge to surface water; and
- o combination of physical and chemical treatment

There are many process options for remediation when organic compounds and metals occur in groundwater. If collection/treatment option is found to be appropriate, recovered groundwater might be discharged directly to the local publicly owned

treatment works (POTW), especially because the local POTW had contracted to accept industrial wastewater from CIBA-GEIGY while the site was active. Newly adopted pre-treatment regulations may need to be evaluated to determine if they apply. The groundwater may contain the same components as waste water did, because waste water leaks and spills may be one of the primary release mechanisms.

Metals might have to be removed from the recovered groundwater. Either alkali precipitation and filtration, or electrochemical treatment, may be appropriate for removal. After removing metals, it may be possible to use an air stripper, followed by granular activated carbon adsorption of the air and/or stripped water, to remove any remaining organic compounds. The collection efficiency, and the mass VOCs removed by stripping, will dictate whether a regeneration system for the vapor recovery system would be necessary. Another potential treatment system is ultraviolet enhanced chemical oxidation. Carbon adsorption alone will also be considered.

Treated groundwater probably could be discharged either to the local POTW, or to the surface water under a National Pollution Discharge Elimination System (NPDES) permit. ReInjection using injection wells or trenches also will be considered.

#### Hydrogeologic Criteria

The geologic and hydrogeologic conditions in the area that may potentially require remediation must be well understood. Geologic information (such as the stratigraphy and depositional history of the subsurface strata) are essential to understanding hydrogeologic conditions. Hydrogeologic information (such as hydraulic conductivity and specific yield) is needed to design an aquifer (i.e., pumping) test.

Aquifer tests would have to be conducted to determine the proper design of the recovery well(s) and treatment system (if necessary).

During the aquifer test, the concentrations of Constituents of Concern would be monitored intermittently to evaluate the effect of pumping. Dilution by "clean" water within the capture zone may result in concentrations below treatment thresholds and/or analytical detection limits. It is not feasible to remediate Constituents of Concern that approach the lower treatability thresholds; it is impossible to evaluate the effect of treatment on Constituents of Concern that are in concentrations below analytical detection limits. If the data from Phase I indicate that groundwater remediation will have to be considered as part of the Corrective Measures Study, then long-duration aquifer tests will be performed in Phase II. These long-duration tests will be developed from hydraulic data collected in Phase I, which includes particle size analysis and in-situ hydraulic testing.

The current analytical data for the facility do not indicate the existence of distinguishable ground water plumes. Rather, the data indicate a number of wells with different chemical signatures. If distinct groundwater plumes cannot be identified, then the quantity of Constituents of Concern in groundwater must have been distributed among a number of source centers -- increasing the size of the potential capture zone. For this reason, any technologies selected may need to be suited to a wide range of compounds and concentrations in order to investigate multiple plumes existing in a small area. Therefore, an evaluation of the vertical as well as horizontal contaminant profile must be estimated for groundwater using a combined geologic, hydraulic, and chemical conceptual model.



### Analytical Criteria

Organic compounds in groundwater may need to be remediated, so, a corrective measure that treats organic compounds will have to be designed. In order to design an appropriate treatment system, the total organic loading into the system must be evaluated. Therefore, at least one round of groundwater samples will be analyzed for library search compounds (tentatively identified non-targeted organic compounds, and their estimated concentrations) in addition to the Appendix IX compounds and fingerprint compounds. In addition, an evaluation of major, minor and trace ionic chemistry is necessary for many of the treatment technology screenings.

Metals observed in ground water also may need to be remediated. The total loading of metals, along with the loadings of specific metals, will be evaluated in order to design an appropriate treatment system. The concentrations of metals that are naturally abundant in ground water (e.g., calcium, magnesium, sodium, potassium, iron, and manganese) also will be evaluated. The possibility of precipitating contaminant metals and chemically substituting metals that are naturally abundant in the groundwater will be evaluated when designing a treatment system. Other parameters such as dissolved gases (i.e., dissolved oxygen), Ph, conductivity, and temperature also will be evaluated.

Because disposal to a POTW or other biotreatment system may be feasible, relevant treatability parameters will need to be collected, including biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total organic carbon (TOC), total petroleum hydrocarbons (TPHC), total kjeldahl nitrogen (TKN), total organic halides (TOX), total dissolved solid (TDS) and nutrients (NH<sub>3</sub>,

NO<sub>3</sub>/NO<sub>2</sub>, PO<sub>4</sub>). Because water may need to be pumped and piped, corrosion/encrustation parameters may be required, including pH, Langlier Index, H<sub>2</sub>S, hardness, silica and alkalinity.

### Bench Scale and Pilot Testing Criteria

At this time, bench scale testing for adsorption, coagulation/flocculation, and precipitation are feasible. Air stripping or steam stripping would probably require an on-site pilot test. If a pump and treat alternative needs to be evaluated, and because of the discrepancies in chemical signatures from well to well, running a test long enough to establish equilibrium flow would be required -- 30 to 90 days may be needed and is probably adequate. The data needed to design these tests have been specified already.

#### 2.5.2 Soil

### Technology Types

Table 2-2 lists technology types for soil remediation. The scope of the Corrective Measures Study will be determined from the Media Protection Standards. Some residual contamination attributable to CIBA-GEIGY operations may exist.

Table 2-2 lists technology types for soil remediation.

The specific technology types are:

- o capping;

- o surface controls;
- o excavation;
- o stabilization;
- o physical treatment;
- o chemical treatment;
- o biological treatment; and
- o in-situ treatment (solvent washing).

In situations where contaminants occur in soil, caps may isolate the contaminants effectively. In-place chemical fixation, off-site chemical fixation, and disposal also may be feasible if the vertical and horizontal extent of soils containing contamination is limited. Land ban regulation may limit off-site disposal options. Various soil washing or extraction techniques will be evaluated. If the contaminants are biodegradable, then biotreatment (either in-situ or in reactors) will be considered.

#### Analytical Criteria

If excavation, treatment, and disposal of soil are appropriate for remediation, total extraction procedure toxicity testing (EP Tox) or toxicity characteristic leaching procedure (TCLP) testing will be required. The soil also will be evaluated to determine if the soil itself could be considered to be a hazardous waste (based on the characteristics or source of the original release). The initial round of soil samples will be analyzed for Appendix IX, library search, and Fingerprint Compound Parameters. In addition, parameters that would be required to evaluate soil treatability are covered by parameters listed in the Order and required by the PHERE. These include cation

exchange capacity, bulk density, TOC, particle size distribution, soil Ph, hydraulic conductivity (saturated zone only), infiltration rate and storage capacity.

### Bench Scale and Pilot Test Criteria

Pozzolanic agents, water/solvent leaching, cultured microorganisms, and incineration or thermal treatment are amenable to bench scale testing. Surface bioreclamation, leaching, or cultured microorganisms may require a pilot scale field test. The data needed to evaluate the feasibility of bench or pilot scale testing have been specified already.

#### 2.5.3 Surface Water

Table 2-3 lists technology types for surface water remediation. At this time, surface controls are most feasible. This would include passive technologies such as separating the possible site sources and sediment sources from the active flow-through of river water.

Because the site is near the lower portion of the Pawtuxet River Basin, there are many sources of pollution upstream. Consequently, it may be difficult to quantify the additive impact to the surface water as a result of conditions at the site. Nevertheless, any impact must be quantified as well as possible. The results of Phase I sampling will help determine the method that would be appropriate to quantify surface water impact.

If there is an impact on the Pawtuxet River as a result of the CIBA-GEIGY site (or of actions attributable to CIBA-GEIGY), then source control of other Media of Concern (ground water, soil, and sediment) are reasonable alternatives.

### Analytical Criteria

The specific additional analytes (required by the Order) that are appropriate to surface water, in addition to Appendix IX include: pH, total dissolved solids, salinity (where appropriate), total suspended solids, biological oxygen demand, alkalinity, conductivity, dissolved oxygen profiles, nutrients ( $\text{NH}_3$ ,  $\text{NO}_3/\text{NO}_2$ ,  $\text{PO}_3$ ), chemical oxygen demand, total organic carbon, and specific contaminant concentrations. These parameters are necessary for evaluating both treatability (if necessary) and suitability as a receptor if a NPDES discharge for groundwater appears to be an acceptable alternative. Major/minor ions have been added to allow comparison with site groundwater.

### Bench Scale and Pilot Test Criteria

Not enough is known yet about surface water conditions. Thus, it is too early to evaluate the need for those tests. The analytical data to be collected as required by the Order are sufficient to evaluate the type of bench scale or pilot tests that would be appropriate in Phase II.

#### 2.5.4 Sediment

Table 2-4 lists technology types for sediment remediation. Because the river quality is class D and on-site sediment control already has been implemented, it is unlikely that current sites conditions would have a significant impact on sediment. However, sediment may have been impacted by past operations. Investigations will identify areas of past releases, evaluating the residuals and the potential for renewed release and transport.

The evaluation of alternative technologies will consider the possibility of stabilizing, treating, removing, or retarding contaminants (if found). Because of the size and volume of the river, there may be considerable impact associated with any remediation. Also, upstream conditions which may continue to pollute the river, must be considered when evaluating remediation schemes.

In a river where Constituents of Concern occur in bed sediment and need to be remediated, corrective measures available include dredging and treating the sediment, or "capping" the bed. Treatment may entail chemical fixation of the sediment, and/or washing of sediment and replacement. Capping with riprap (or with geotextile covered with riprap) is designed to minimize contact with bed sediment.

#### Analytical Criteria

The specific analytes (required by the Order) that are appropriate to sediment, in addition to Appendix IX include: nutrients ( $\text{NH}_3$ ,  $\text{NO}_3/\text{NO}_2$ ,  $\text{PO}_4$ ), grain size distribution, density, total organic carbon content, ion exchange capacity, and pH. These

parameters are necessary for evaluating treatability (if necessary) for comparison with on-site soils, and for evaluating the interaction between surface water and resuspended sediment. Major/minor ions have been added to allow comparison with site groundwater.

### Bench Scale and Pilot Test Criteria

Not enough is known yet about sediment conditions. Thus, it is too early to evaluate the need for these tests. The analytical data to be collected as required by the Order are sufficient to evaluate the type of bench or pilot tests that would be appropriate in Phase II.

## 2.6 ANALYTE LISTS

During the first two phases of the RCRA Facility Investigation the soil, water, and sediment samples will be tested to identify the presence and concentrations of chemical compounds and other parameters. These tests are needed in order to meet the objectives of the PHERE and Corrective Measures Study. Analyte Lists are lists of chemicals of special significance either to human health or the environment, or to treatability. This section discusses the Analyte Lists which will be employed during the Facility Investigation. The Release Characterization Investigation plan, including the location, type, and frequency of sample collection, is discussed in detail in Chapter 3, Section 4.

The Order requires sampling of the soil, ground water, surface water, and river sediment. These samples must be tested, at a minimum, for chemical compounds which

are listed in 40 CFR Part 264, Appendix IX of the Resource Conservation and Recovery Act. Appendix IX is a list of chemical compounds which, in environmental media, may indicate that a release of a regulated chemical may have occurred. The Order also requires that certain geotechnical parameters be evaluated for each stratigraphic unit, and that certain geotechnical and indicator parameters be evaluated for surface water and sediment.

Other Analyte Lists must be developed that are specific to this site and to the manufacturing operations which were conducted on the site. These other Analyte Lists, which may exceed the minimum requirements of the Order, are proposed to help meet the objectives of the PHERE and the Corrective Measures Study.

Separate Analyte Lists have been developed based on the implications of the presence of specific analytes. Although some specific analytes could have appeared on several lists, analytes have not been duplicated across lists. For example, pH is a physicochemical measurement that has implications for corrosion and encrustation, acceptance by POTW plants and NPDES compliance, and biotreatability.

Any chemical compound will be found on only one list in this RFI. The absence of a chemical compound from a given list does not imply that the compound will not be used to evaluate treatability or to assess the risk to public health and the environment. Taken together, the lists may be reviewed as defining the overall scope of the laboratory analyses.

Samples will be handled by the analytical laboratory in compliance with the requirements for the test(s) to be conducted. Standard test procedures have been



developed by the USEPA and by national organizations such as the American Society for Testing and Materials (ASTM). Applicable procedures are included in Chapter 4 - Quality Assurance Plan.

The presence of metals will be determined using the standard RCRA methods, regardless of which Analyte List contains the metallic compounds (e.g., Appendix IX, Major/Minor Ion List, and so on). Organics will be analyzed using the appropriate RCRA method. For example, volatiles on the Appendix IX List and on the Library Search List will be analyzed at the same time. The presence of semi-volatiles, PCB/pesticides, and other organic fractions will be analyzed using splits of a given sample but employing extracts and equipment specified by the appropriate test methods.

#### 2.6.1 Appendix IX

Appendix IX analytes were promulgated by the USEPA as a part of the TSD Facility Standards of the RCRA regulations (40 CFR, Part 264, Appendix IX). This list identifies the chemicals whose presence/absence must be established for certain groundwater monitoring and corrective action programs.

Appendix IX is a derivative of the Identification and Listing of Hazardous Wastes (40 CFR, Part 261, Appendix VIII). Appendix VIII lists chemicals whose presence may cause waste to be classified as hazardous by the USEPA. Appendix VIII is an informational list; analytical methods are not available for all Appendix VIII substances. However, it is an important tool for the USEPA in determining whether a chemical compound from a specific source at a specific site should be listed as hazardous.

Table 2-5 lists the common names of chemical compounds which appear in Appendix IX and require analysis; the table is taken from the RCRA regulations. In addition to the common names, Table 2-5 also shows the CAS Registry Number for the compound, the suggested test procedure, and the procedure's Practical Quantification Limits (PQLs).

The presence at a site of chemical compounds found in Appendix IX is an important input to the PHERE and to the Corrective Measures Study. Appendix IX analytes will be the main group evaluated during the Facility Investigation.

#### 2.6.2 Library Search

Other nonregulated organic compounds that do not appear in Appendix IX may, nonetheless, be very important to evaluating treatability at the site. The laboratory will determine the mass spectrograph of up to 30 chemical compounds found in significant concentrations in samples from the site. Up to 10 compounds will be identified in the volatile fraction and up to 20 in the semi-volatile fraction. These will be tentatively identified using the Mass Spectral Library of the National Bureau of Standards (1985).

#### 2.6.3 Fingerprint Compounds List

Fingerprint compounds are specific chemicals unique to the activities at the CIBA-GEIGY facility in Cranston, Rhode Island. This section identifies the fingerprint compounds and describes the rationale by which they were chosen for analysis. The selection of fingerprint compounds was not a requirement of the Order, but was

incorporated into this work plan to ensure a more complete investigation. In addition, fingerprint compounds were necessary to satisfy the intent of the Order.

Fingerprint compounds were selected based on:

- o a review of chemical production and usage records to identify those chemicals that are unique to the facility but are not on Appendix IX;
- o the toxicology of these chemicals; and
- o the physicochemical properties of these chemicals, including their potential for degradation and transport.

The raw materials and intermediates (including 15 Appendix IX chemicals), as well as the final products used or manufactured at the facility, were scored for three criteria -- toxicity, mobility, and persistence. The scores for each chemical were multiplied across criteria to obtain factor numbers for each chemical. The factor numbers for chemicals were ranked in descending order; the final chemical products of the facility were ranked separately from the raw materials and intermediates used at the facility.

For raw materials and intermediates, Appendix IX chemicals received the highest scores. It was determined that the potential health risk arising from the raw materials and intermediates will be evaluated adequately by analyzing for Appendix IX chemicals.

Scores for the final products were ranked within product categories. The following chemicals were selected as fingerprint compounds:

- o Imipramine (Tofranil)
- o Phenylbutazone (Butazolidin)
- o Propazine
- o Tinuvin 327

Additional candidate fingerprint compounds include Irgasan CF3, Irgasan DP300, and their related by-products. One or both of these will be selected as fingerprint compounds, depending on the outcome of the matrix recovery studies described in Chapter 4, Part B - Quality Assurance Project Plan.

#### 2.6.4 Ground Water Treatability Lists

The three lists discussed so far do not include all of the site-specific chemical compounds whose presence would have an impact on the treatability of groundwater at the site. These additional analytes will be included in five generic lists:

- o a Physicochemical List;
- o a Major/Minor Ions List;
- o a Corrosion/Encrustation List;
- o a POTW/NPDES List; and
- o a Nutrients List.

Table 2-6 shows the specific analytes on these five generic lists for groundwater treatability.

#### 2.6.5 Soil Treatability Lists

Similarly, the lists discussed so far do not include all of the site-specific chemical compounds whose presence would have an impact on the treatability of soils and riverbed sediment. These additional analytes will be included in five additional generic lists:

- o a Physicochemical List;
- o a Major/Minor Ions List;
- o a Geotechnical List;
- o a Characteristics List; and
- o a Nutrients List.

Table 2-7 shows these five generic lists for soil treatability.

#### 2.6.6 Surface Water Treatability Lists

The additional analytes that are necessary to evaluate treatability of surface water are included on four generic lists:

- o a Physicochemical List;
- o a Major/Minor Ions List;
- o a NPDES List; and

- o a Nutrients List.

Table 2-8 shows the specific analytes on these four generic lists for surface water treatability.

#### **2.6.7 Sediment Treatability Lists**

The additional analytes that are necessary to evaluate treatability of sediments are included on four generic lists:

- o a Physicochemical List;
- o a Major/Minor Ions List;
- o a Geotechnical List; and
- o a Nutrients List.

Table 2-9 shows the specific analytes on these four generic lists for sediment treatability.

### **2.7 SUMMARY**

As required by the Order, this section identified the potential corrective measure technologies that may be used to contain, treat, remedy, and/or dispose of contamination resulting from the release of hazardous waste and/or hazardous constituents at the SWMUs or other AOCs in the facility. This section summarized the data from previous investigations, and also identified data needs for the RFI. Potential technologies for corrective measures addressed each of the Media of Concern -- groundwater, soil,

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surface water, and sediment. This Preliminary Investigation of Corrective Measures -- together with the Physical Site Characterization Study work plan (presented in the next section), the Release Characterization work plan (Section 4), and the Source Characterization work plan (Section 5) -- allows definition of the Preliminary Phase II Proposal (Section 6).

**VOLUME 1 - CHAPTER 3**  
**FACILITY INVESTIGATION WORK PLAN**

**SECTION 3**  
**PHYSICAL SITE CHARACTERIZATION STUDY (PHASE IA)**

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This section proposes a work plan for the Physical Site Characterization Study, Phase IA of the RCRA Facility Investigation. In Phase IA, four categories of investigations will be performed to characterize the facility's physical environment:

- o three geophysical investigations;
- o a geologic investigation;
- o a hydrogeologic investigation; and
- o a hydrologic investigation.

At the conclusion of the entire Physical Site Characterization Study, the results will be summarized and a Release Characterization Strategy for Phase IB will be developed. The strategy will be reviewed and approved by the USEPA prior to beginning Phase IB. The Physical Site Characterization study is described here. The objectives, strategy, methods, and justification are provided for each investigation.

**3.1 GEOPHYSICAL INVESTIGATIONS: OVERVIEW**

Geophysical investigations will be performed as part of Phase IA to characterize the subsurface conditions beneath the facility. The geophysical investigations entail three types of surveys: a ground penetrating radar survey, a seismic refraction survey, and an electrical resistivity survey. The results of these investigations, when combined with other Phase IA characterization data, will be used to refine the Release Characterization Strategy proposed for Phase IB. The three geophysical investigations are described here. The



objectives, strategy, methods, and justification are presented for each investigation.

## **3.2 GEOPHYSICAL INVESTIGATIONS: GROUND PENETRATING RADAR SURVEY**

### **3.2.1 Introduction**

A ground penetrating radar (GPR) survey of the facility will focus on locating shallow subsurface features that could affect ground water flow or contaminant migration. Data generated during the survey will be compared to the facility's utility plans, and potential reflectors will be identified. In conjunction with data from the other Phase IA investigations, a model of the subsurface will be developed. After reviewing the model, sampling locations and monitoring wells proposed for Phase IB will be modified, if necessary.

### **3.2.2 Objectives**

Data collected in the GPR survey will be used to:

- o locate and map existing subsurface features beneath the site (e.g., foundations, utilities, trenches); and
- o evaluate the facility's shallow unconsolidated deposits.

### **3.2.3 Strategy**

The GPR survey will be used as a surface-based reflection profiling technique, similar to seismic reflection. The survey will use a Geophysical Survey Systems SIR System 8 (or equivalent equipment). The survey will be performed at the facility's three on-site areas. Prior to beginning the GPR survey, transects will be established in each study area. Continuous graphical records of the subsurface will be generated and evaluated after each traverse.

The GPR survey involves irradiating the near subsurface with wide-band, short-duration electromagnetic energy from a transmitting antenna, and intercepting energy reflected from various subsurface features with a receiving antenna. The return (i.e., reflected) signal will be amplified and processed, converting it to a graphical record that facilitates interpretation.

Because electromagnetic energy loses its strength rapidly in conducting materials, ground penetrating radar is a shallow-penetration technique. Penetration depths are rarely more than a few tens of meters; the majority of GPR surveys provide useful information only to 3 or 4 meters deep. GPR works well in resistive materials (such as dry rocks, or clean sand that has been saturated with fresh water). GPR does not work as well in conductive materials (such as clay, or rocks with conductive pore fluid).

Reduction and interpretation of the GPR survey data will consist of plotting reflection anomalies over each surveyed transect. GPR records will be compared to the facility's utility plans, and reflection patterns consistent with man-made subsurface features will be identified. Using data collected from boreholes, test pits, or other geophysical methods, a subsurface model consistent with all available information will be developed.

#### **3.2.4 Methods**

Methods and procedures that will be used to collect, reduce, and interpret the GPR survey data are described in Volume 2 - Project Quality Assurance Plan (Section 6).

#### **3.2.5 Justification**

In the Production Area, many subsurface features exist that could effect ground water and contaminant migration. Because these features cannot be

located using the other proposed geophysical techniques, a complimentary GPR survey will be performed to characterize the facility's shallow subsurface. Site plans that show existing subsurface features are presented in Volume 1 - Current Assessment Summary Report (Section 2, Figures 2-3A and 2-3B). In the Production Area south of the railroad tracks, the GPR survey will be performed in a survey mode along 10-foot transects in both directions to maximize the amount of descriptive information obtained. In the Waste Water Treatment Area and Warwick Area, only a limited number of subsurface obstructions exist. For these study areas, the GPR survey will be performed in a reconnaissance mode along 20-foot transects in both directions.

### **3.3 GEOPHYSICAL INVESTIGATIONS: SEISMIC REFRACTION SURVEY**

#### **3.3.1 Introduction**

A seismic refraction survey will be performed to provide continuous profiles of the underlying rock and other refracting units within the overburden. The investigation also will use information collected at the facility in October 1989 (data on file with Woodward-Clyde Consultants) and data generated from additional seismic survey lines.

#### **3.3.2 Objectives**

Data collected in the seismic refraction survey will be used to evaluate:

- o the depth of bedrock;
- o the top of the water-saturated zone; and
- o the tops of other stratigraphic units that sustain refractions.

### 3.3.3 Strategy

In October 1989, seven seismic refraction lines were investigated at the facility's three on-site areas (Figure 3-1). In Phase IA, these data will be reviewed and will be corroborated both with existing information and with field data generated by the other Phase IA investigations. As part of this review, the October 1989 seismic lines will be plotted on the site topographic maps, and the elevations of the seismic sources and geophone receivers will be determined to verify the accuracy of the data collected in October 1989.

Supplementary seismic refraction lines are shown in Figure 3-1. The three additional traverses will be performed using a Bison GEOPRO 12-channel signal enhancement seismograph (or equivalent equipment). The receiving geophones will be aligned with the traverses at intervals ranging from 15 to 30 feet. (The exact geophone spacing will be determined by trial recordings performed in the field.) During the survey, either a hammer or an explosive signal source will be used. Explosive signal sources, if needed, will be detonated by a licensed blaster.

Each supplementary seismic line will be designated by survey markers at the ends of the line. Positions of the geophones will be determined by measuring from either of the end-of-traverse markers. The elevation of each geophone will be established (to the nearest foot) by reference to the site topographic map.

At least five seismic sources of energy (shots) will be generated for each seismic line (spread). Two shot points will be located at the ends of the spread (each at 10 to 20 feet from an end geophone); a third will be located at the midpoint of the spread. The other two shot points will be offset from the two end shot points. These two offset shot points will be located so as to allow refractions from rock to be measured at each of the geophones along the spread. (The exact offset distances will be determined in the field using trial recordings). The position (relative to traverse markers) and depth of each shot will be recorded. The elevation of each shot point also will be determined by reference to a site topographic map.

Prior to recording the refraction events, the appropriate instrument settings (e.g., gain, filter, delay, and sweep settings) will be entered into the seismograph. The survey for each spread will proceed from shot point to shot point until each of the five points has been completed. After each shot, data will be reviewed in the field and any necessary adjustments will be made.

The seismic refraction survey data will be processed, analyzed, and interpreted. A paper record (seismogram) of all recordings will be generated. With these records, seismic refraction events will be identified and timed, and the necessary time-distance plots will be drawn. Time and distance information will be analyzed using the SIPT2 computer software of the USGS to generate refractor depth and velocity information by time-delay and ray tracing techniques. Tables depicting depth and elevation of refractors beneath each geophone and shot point will be prepared along with a graph presenting this information as a vertical section. Geologic information from these borings will be included in the cross-sections. A structural contour map will be developed for the portions of the site having sufficient refraction data. Velocity data for each refracting unit also will be tabulated. Borings will be advanced along selected profiles to confirm the accuracy of the seismic survey.

Prior to beginning the seismic refraction survey, subsurface features (e.g., utilities, foundations) will be located using GPR. These subsurface features can interfere with the acquisition of refraction survey data. If possible, the location of the seismic refraction survey lines will be modified to minimize the effect of these potential sources of interference. Data usability will depend on conditions encountered in the field and will vary from seismic line to seismic line.

#### **3.3.4 Methods**

Methods and procedures that will be used to collect, reduce, and interpret the seismic refraction survey data are described in Volume 2 - Project Quality Assurance Plan (Section 6).

### **3.3.5 Justification**

Justification of the seismic refraction survey is discussed with the justification for the electrical resistivity survey (Section 3.4.5).

## **3.4 GEOPHYSICAL INVESTIGATIONS: ELECTRICAL RESISTIVITY SURVEY**

### **3.4.1 Introduction**

An electrical resistivity survey will use data collected at the facility in October 1989 and will generate new data from supplementary soundings. The electrical resistivity survey will be performed along the supplementary seismic lines; the data from this survey will help to characterize the facility's stratigraphy.

### **3.4.2 Objectives**

Data collected in the electrical resistivity survey will be used to:

- o evaluate the depth and thickness of the underlying stratigraphic units;
- o locate the presence of perched water tables (anomalous aquifer properties); and
- o corroborate field data collected during the seismic refraction survey and the boring program.

### **3.4.3 Strategy**

In October 1989, six electrical resistivity soundings were performed at the facility's three on-site areas (each shown on Figure 3-1 as an "x" along a solid line). In Phase IA, these data will be reviewed and will be corroborated both with existing information and with field data generated by the other Phase IA investigations. Three additional resistivity soundings will be performed at the locations shown in Figure 3-1 ("x" on dashed line). Similar to the previous seismic refraction survey, the additional soundings will be located at the center of the seismic traverses and will be aligned with the spreads. An ABEM Terrameter SAS

300 transmitter/receiver (or equivalent equipment) will be used to conduct the survey.

The Schlumberger electrode configuration will be used at the sounding locations. This configuration entails driving four steel electrodes into the ground along the sounding alignment. Current is passed between the outer two stakes (current electrodes), and the resulting voltage is measured between the inner two stakes (potential electrodes). As the stakes are spread further apart, the depth of electrical penetration increases. For each sounding, 24 resistivity measurements will be performed.

After completing all measurements at the first location, the equipment will be moved to the second sounding location and the procedure will be repeated. Once the survey has been completed, the data will be processed, analyzed, and interpreted.

Resistance values will be converted to apparent resistivity values using the Schlumberger geometric factor; the apparent resistivity values will be plotted. Apparent resistivity values will be converted to true resistivity values as a function of depth by means of the Keck or Zhody (USGS) mathematical inversion routines. These true resistivity values also will be graphed on a log-log scale to show their relationship with depth.

The sounding data will be compared both with the seismic refraction survey data and with boring log information. This comparison will allow interpretation of subsurface stratigraphy and may also generate questions or suggest data gaps. If so, recommendations will be made for additional sounding or boring programs that will resolve these issues.

Prior to beginning the electrical resistivity survey, subsurface linear conductors (e.g., pipelines, utilities) will be located using GPR. These conductors can interfere with the acquisition of resistivity data. If possible, the orientation of the resistivity lines will be perpendicular to such features. Data usability will depend on conditions encountered in the field and may vary from sounding to sounding.

#### 3.4.4 Methods

Methods and procedures that will be used to collect, reduce, and interpret resistivity data are described in Volume 2 - Project Quality Assurance Plan (Section 6).

#### 3.4.5 Justification

The location and distribution of the supplementary geophysical survey lines (for both seismic refraction and electrical resistivity) have been chosen to provide an adequate characterization of subsurface data without drilling an excessive number of borings. The seismic refraction and electrical resistivity surveys will be performed in all three on-site areas, at locations critical to the Phase IA investigation. Data generated during these surveys will be corroborated both with borings and with other information obtained in Phase IA.

The geophysical investigations will use data collected at the facility in October 1989 as well as new data generated from the three supplementary geophysical lines. Both the seismic refraction and electrical resistivity surveys will be performed along the Pawtuxet River bulkhead in the Production Area. Geophysical data from these surveys will be correlated with data from borings (existing and proposed) advanced in this area in order to understand the hydrogeology in this area of the site. The two other supplementary geophysical survey lines will be in the Waste Water Treatment and Warwick areas. Both lines will provide additional subsurface data in areas potentially impacted by past facility releases.

### 3.5 GEOLOGIC INVESTIGATION

#### 3.5.1 Introduction

The geologic history of the facility area will be established as part of the Physical Site Characterization Study. A comprehensive geologic investigation will be made that will include three tasks -- a literature review of relevant data



sources, field mapping of bedrock in the site area, and a physical geologic investigation of the immediate facility environment. Overall, this comprehensive investigation will place the site in a regional geologic setting and will then focus on the site-specific geology. The results of this comprehensive geologic investigation, when combined with other Phase IA data, will be used to refine the Release Characterization Strategy proposed for Phase IB.

### **3.5.2 Objectives**

A detailed geologic investigation is an integral part of a Physical Site Characterization study. Data collected during the literature review and field mapping tasks will be evaluated to characterize the regional and local geomorphology, surficial geology, bedrock lithology, and bedrock structure. These data will be used to develop a model of the area; the model will be used to assess the geologic characteristics of the facility.

The physical geologic investigation task will focus on obtaining site-specific information. The objectives of this task include:

- o characterizing the facility's geologic environment;
- o identifying potential contaminant migration pathways; and
- o corroborating information collected using indirect methods (such as the geophysical surveys).

### **3.5.3 Strategy**

The geologic investigation will consist of three tasks. The first task, a literature review of available geologic data, will be used to place the site in its regional tectonic setting and will provide a framework for detailed site-specific geology. Potential sources for relevant data include:

- o the United States Geologic Survey;
- o the Rhode Island Department of Environmental Management;
- o local universities;
- o technical journals; and

- o aerial photography agencies and companies.

The second task, field mapping, will note and sample bedrock exposures on-site and in the surrounding areas. Geologic structures including faults, joints, cleavages, and metamorphic fabrics will be measured and recorded. These measurements will characterize the geologic properties of bedrock underlying the site and surrounding areas.

The third task, the physical geologic investigation, will involve analyses of surface and subsurface data obtained from on-site characterization tasks. Data will be collected from soil borings, rock cores, and subsurface soil samples. The site-specific soils and stratigraphic units will be correlated with the regional stratigraphy both to provide an overview of the overburden and to evaluate its depositional history. Bedrock cores will be logged and correlated both to surrounding exposures and to the regional geology. Soil samples will be tested in the laboratory for physical properties that affect contaminant mobility. The detailed methodology of this third task is presented next.

#### **3.5.4 Methods**

Drilling and sampling activities that are required by the physical geologic investigation consist of:

- o advancing borings;
- o soil sampling;
- o rock coring;
- o field screening of subsurface samples; and
- o laboratory testing of soil.

Specific procedures for these activities are described in Volume 2 - Project Quality Assurance Plan (Section 6). The scope of the physical geologic investigation is presented here. Sampling locations are presented in Figure 3-2.

**Bedrock Monitoring Wells.** Four test borings, designated RW-1 through RW-4, will be advanced 10 feet into bedrock using hollow stem auger methods through

the overburden and using either air or dual rotary methods in rock. The locations of these borings are shown in Figure 3-2; geologic sampling data are summarized in Table 3-1. These borings will be sampled continuously using split-spoon sampling techniques in unconsolidated overburden and using rock coring techniques in bedrock. Twenty feet of bedrock core will be recovered from each of the borings, but only the upper 10 feet will be reamed for the monitoring well. Soil samples will be classified on-site by a geologist following the Unified Soil Classification system; rock cores will be logged following the operating procedures described in Volume 2 - Project Quality Assurance Plan (Section 6).

**Piezometers.** Deep piezometers either will be installed in test borings that reach, but do not penetrate, a confining unit (e.g., till), or will be installed in borings that reach bedrock if a confining unit is not encountered during drilling. Five deep piezometers will be installed. The planned locations of these piezometers are shown in Figure 3-2; geologic sampling data are summarized in Table 3-1. These borings will be sampled continuously using split-spoon sampling techniques and will be classified on-site by a geologist using the Unified Soil Classification system.

**Soil Samples.** All samples recovered from the monitoring wells and piezometer borings will be screened for volatile organic compounds with an OVA or HNu ionization detector. Soil samples from physical characterization borings (e.g., rock well and deep piezometer borings) will undergo geotechnical testing. Soils will be sampled in the unsaturated zone (just above the water table) and from every significant stratigraphic unit penetrated by the boring. Samples of glacial till, if encountered, will be recovered using Denison tube samplers or rock core barrels. If till recovery is poor, in-situ permeability testing (such as falling head or constant head tests) will be performed. The geologic sampling program is summarized in Table 3-1. Geotechnical testing of soil samples will include hydraulic conductivity, bulk density, porosity, and particle size analyses. The rationales for these specific tests were discussed previously (Sections 2.5.2 and 2.6).

### **3.5.5 Justification**

The locations, depths, and distribution pattern of the proposed test borings have been chosen primarily to optimize collecting the data needed to characterize the hydrogeologic and hydraulic conditions of the site. The bedrock wells were sited primarily to provide data on the bedrock aquifer; the piezometers were sited to characterize the aquifer above the till or bedrock confining layer more completely. In part, however, the borings were sited using stratigraphic data obtained from existing borings. The new borings will provide coverage that enhances the geologic characterization of the site and that complements the other physical site characterization investigations. Borings that are advanced for release characterization monitoring wells also will be used to obtain geologic information.

The monitoring wells are distributed roughly evenly across the site, and will provide optimum information about the bedrock aquifer and structure. The monitoring wells are positioned so as to generate both a complete stratigraphic cross-section of the site and a bedrock cross-section (if the bedrock structure is not exceedingly complex).

The piezometers will be located so as to generate a cross-section perpendicular to the bedrock cross-section. Taken together, the two cross-sections should provide a nearly three-dimensional view of the site stratigraphy.

## **3.6 HYDROGEOLOGIC INVESTIGATION**

### **3.6.1 Introduction**

The facility's hydrogeologic conditions will be evaluated (1) by installing and testing piezometers and bedrock monitoring wells for sustainable ground water flow volumes, (2) by monitoring water levels, and (3) by performing a literature review of relevant data sources. During this hydrogeologic investigation, no attempt will be made to characterize the ground water hydraulics of a particular SWMU, AOC, or AAOI. Rather, a broader approach to evaluate the hydraulic conditions associated with the facility will be presented. The results of the

hydrogeologic investigation, when combined with other Phase IA data, will be used to refine the Release Characterization Strategy proposed for Phase IB.

### **3.6.2 Objectives**

Data collected in the hydrogeologic investigation will be used to:

- o identify appropriate locations for monitoring wells;
- o characterize the uppermost aquifer;
- o determine ground water flow paths and gradients;
- o evaluate seasonal variations in ground water flow;
- o identify aquifer types and boundaries; and
- o evaluate hydraulic conductivities of the stratigraphic units.

### **3.6.3 Strategy**

Eleven point piezometers will be installed at the locations shown in Figure 3-3. These new piezometer locations complement the existing monitoring network. Both shallow and deep piezometers will be installed to measure ground water elevations at discrete intervals within the upper aquifer. Shallow piezometers will be advanced 5 feet below the water table; deep piezometers will be installed just above the confining layer (e.g., till, clay, bedrock). The depth of the confining layer will be determined from test borings drilled during the physical geologic investigation.

Four bedrock monitoring wells will be installed at the locations shown in Figure 3-3. The bedrock monitoring wells are located to complement the existing monitoring network. One well will be located in each of the three on-site study areas. The fourth well will be located in the transition area between the Production Area and the Waste Water Treatment Plant Area. The bedrock monitoring wells will be installed 10 feet into bedrock, and will be sampled in Phase IB to evaluate the quality of the ground water in the bedrock aquifer.

All newly installed piezometers and monitoring wells will be tested to evaluate the hydraulic conductivity of the underlying formations. Test data will

be evaluated using an ISOAQX® software package (Hydrologic, 1987) or equivalent. Water level monitoring of all piezometers, monitoring wells, and stream gauges will be performed quarterly (Table 3-2). Water level monitoring will begin after the new piezometers and wells have been installed and will continue until preparation of the RFI Report begins.

A literature review will be conducted as part of the hydrogeologic investigation to examine regional hydrogeologic flow patterns (including areas and amounts of ground water recharge and discharge, and rates of infiltration). The literature review also will re-evaluate the hydrogeologic data collected during the Preliminary Investigation.

#### 3.6.4 Methods

Methods applicable to the hydrogeologic investigation are described in Volume 2 - Project Quality Assurance Plan (Section 6). These methods include piezometer and monitoring well installation procedures, water level monitoring techniques, and hydraulic conductivity test procedures.

#### 3.6.5 Justification

Eleven piezometers will be installed in the Phase IA hydrogeologic investigation:

- o three shallow piezometers will be installed in the Warwick Area;
- o two deep piezometers will be installed near existing monitoring points in the Warwick and Waste Water Treatment areas; and
- o three nested pairs will be installed in the Warwick Area and in the transition area between the Production and Waste Water Treatment areas.

In addition, four bedrock monitoring wells will be installed in the Phase IA hydrogeologic investigation.

**Shallow Piezometers.** Three shallow piezometers (P-15S, P-16S, and P-17S) will be installed in the western part of the Warwick property in an area currently lacking monitoring coverage (Figure 3-3). Although no SWMUs, AOCs, or AAOIs are located in this part of the site, the piezometers will provide the ground water data necessary for a comprehensive hydraulic characterization. Hydraulic data obtained from these piezometers will be used to determine the water table depth, the ground water flow patterns in the upper part of the aquifer, and the hydraulic conductivities of the underlying strata.

**Deep Piezometers.** Hydraulic data are needed to describe the deeper part of the overburden aquifer in the Warwick and Waste Water Treatment Areas (Figure 3-3). Two deep piezometers (P-18D and P-19D) will be installed near existing monitoring points to provide the ground water data necessary for a comprehensive hydraulic characterization. In the Warwick Area, piezometer P-18D will be installed to evaluate the hydraulic conditions beneath SWMU-5. In the Waste Water Treatment Area, piezometer P-19D will be installed near existing piezometers P-7S and P-7D. Ground water data collected from all of these piezometers will be used to evaluate the vertical variation of hydraulic head, the flow directions at depth, and the hydraulic conductivities of the underlying strata.

**Nested Piezometer Pairs.** Three nested piezometers pairs (P-20S/D, P-21S/D and P-22S/D) will be installed in areas of the site that lack adequate hydraulic characterization. These nested pairs will provide hydraulic data that will be used to assess ground water flow patterns, gradients, aquifer boundaries, and hydraulic conductivities of the underlying strata. The nested pairs are aligned with the existing piezometer pair (P-14S/D) to permit generating hydrologic cross-sections.

**Release Characterization Monitoring Wells.** Twelve monitoring wells will be installed as part of the Release Characterization. These wells will be installed primarily to evaluate water quality downgradient of SWMUs. However, they will also be used to determine the water table depth, the ground water flow patterns, and the hydraulic conductivities of the underlying strata.

**Bedrock Monitoring Wells.** Four bedrock monitoring wells will be installed,

one in each of the three on-site study areas, and one in the transition area between the Production Area and the Waste Water Treatment Area, to evaluate the hydraulic conditions of the bedrock aquifer. Monitoring the bedrock aquifer was not addressed in previous investigations at the facility, and hydraulic data on the bedrock aquifer are needed throughout the site. Two wells (RW-1 and RW-2) will be installed in downgradient areas of the Production and Waste Water Treatment Areas near existing shallow monitoring wells. In the Preliminary Investigation, ground water contaminants were detected within these shallow wells. Well RW-3 will be installed to determine if ground water within the bedrock aquifer has been affected by storing river sediments in this area (SWMU-5). Well RW-4 will be installed to evaluate ground water quality between the Production and Waste Water Treatment Areas. Ground water data collected from these wells will be used to evaluate the vertical variations in hydraulic head, the flow directions at depth, and the hydraulic conductivities of the bedrock.

### 3.7 HYDROLOGIC INVESTIGATION

#### 3.7.1 Introduction

The hydrologic investigation will examine the physical characteristics of the Pawtuxet River and will evaluate these characteristics for the potential movement and transport of Constituents of Concern. The hydrologic investigation includes (1) a literature review, (2) bathymetric surveying, (3) water discharge monitoring, (4) suspended sediment discharge monitoring, and (5) bed sediment sampling. The results of the hydrologic investigation will be used to refine the Release Characterization Strategy proposed for the Pawtuxet River in Phase IB (see Section 4).

#### 3.7.2 Objectives

Data collected in the hydrologic investigation will be used to describe:



- o the surface water bodies within the site and its environs;
- o the location, elevation, flow rates, depth, width, seasonal variation, flood potential, and state classification of streams;
- o the drainage patterns;
- o the riverbed sediment depositional area(s);
- o the riverbed sediment thickness profile(s);
- o the grain size distribution, bulk density, ion exchange capacity, pH, porosity, and total organic carbon content of bed sediment; and
- o the seasonal variation in suspended and bed sediment transport.

### 3.7.3 Strategy

The hydrologic study consists of five interrelated tasks. The first task, a literature review, will provide information necessary to describe surface water bodies potentially affected by releases from the facility. The other four tasks are specific to the Pawtuxet River and are designed to characterize its physical environment.

#### Literature Review

The literature review will be similar to that conducted as part of the Current Assessment Summary Report (Section 6). The review will involve contacting state and federal agencies and searching CIBA-GEIGY files to find data pertinent to the hydrologic investigation. The literature review also will include, if appropriate, a re-evaluation of the hydrologic data presented in the Current Assessment Summary Report (Section 6).

It is currently believed that the Pawtuxet River is the only surface water body requiring investigation as part of the RCRA Facility Investigation (RFI). However, an inventory of temporary and permanent surface water bodies potentially impacted by releases from the facility will be taken in Phase IA of the RFI. If it is determined that additional surface water bodies warrant

investigation, they will be addressed in Phase IB.

The surface water inventory will be based primarily on maps and aerial photographs. Impoundments identified on the maps or photographs will be described in terms of location, elevation, surface area, depth, volume, amount of freeboard, and purpose of the impoundment. (Swimming pools are not considered impoundments.) If necessary, a field reconnaissance will be conducted to provide the data needed to describe the impoundments.

Streams will be described based on location, flood potential, and stream classification. The regional drainage pattern will be described based on published geomorphologic data. The facility-specific drainage pattern will be mapped based on topographic features, drainage structures, and observations of water flow during a storm event. Finally, flow regulation associated with the Scituate and Flat River reservoirs will be researched and quantified.

#### Bathymetric Survey

A river reconnaissance will be conducted to evaluate the navigability of the Pawtuxet River, to help identify the location of the former facility outfalls, and to establish the bathymetric transect end points. The bathymetry of the Pawtuxet River in the vicinity of the site will be surveyed using an electronic fathometer and/or a manual lead line. Bathymetric data will be collected along transects that run perpendicular to the river channel. The end points of each transect will be surveyed to determine the distance between each pair of end points and to permit scaling of the bathymetric profiles. The transects will be spaced at nominal 250-foot intervals and the area of coverage will extend over a reach along the river of approximately 2250 feet. Ten transects across the Pawtuxet River will be run, extending from just upstream of the confluence of the Bellefont Pond drainage stream to just downstream of the Warwick Avenue bridge. (For the purposes of this proposal, this area has been designated as the facility reach.)

Figure 3-4 shows the approximate locations of the proposed bathymetric transects. Five of the transects will terminate at the locations of former outfalls associated with the facility. Transects within the facility reach are designated with "TR-F" followed by a number. The numbers are sequential and increase in value downstream. Therefore, transect "TR-F01" represents the transect furthest upstream in the facility reach.

Longitudinal surveys of the facility reach will be conducted to identify bed forms (if any) that are indicative of bedload transport and to delineate features (e.g., outfalls) that run perpendicular to the river banks. Based on the conditions observed while on the river, additional bathymetric measurements may be taken to delineate apparent areas of sediment deposition. These sediment deposits will be compared to the locations of the facility's outfalls.

The water surface elevation of the Pawtuxet River will serve as a baseline for bathymetric measurements. The elevation at the time of the bathymetric survey will be referenced to a temporary benchmark established specifically for measuring surface water elevation. The surface water elevation can then be related to the ground water information.

### Water Discharge Monitoring

The water discharge volume flowing in the Pawtuxet River will be monitored using the USGS mid-point method. The locations of the upstream and downstream transects will be chosen based on the results of the bathymetric survey. The criteria for choosing discharge volume monitoring transects include profile geometry, flow characteristics, and obstructions. Regular geometry and flow, and maximum distance from obstructions (e.g., bridge abutments and bed debris), are desirable when establishing a discharge volume monitoring transect.

If river conditions permit during Phase I, water discharge will be determined during two low-flow events and one high-flow (i.e., storm) event. Regardless of

river conditions, two discharge events will be recorded during Phase I. The river's discharge will be monitored between Phase I and Phase II, and monitored quarterly during Phase II. The water discharge data will be compared to the stream gauge data for the middle reach of the main stem of the Pawtuxet River (river mile 4.4). (This stream gauge is maintained by the USGS.) This comparison permits calculating water discharges using multivariate correlation techniques. Scaling factors will be computed based on empirical and calculated data, so that the discharge measured at the USGS gauging station can be converted into upstream and downstream discharges representative of the Pawtuxet River at the facility.

Surface water discharge will be monitored upstream and downstream of the facility at the locations of transects TR-F01 and TR-F10, respectively. If those transects are not appropriate, additional transects will be run in the vicinity of transects TR-F01 and TR-F10. The purpose of monitoring the discharge upstream and downstream of the facility is to determine if an increase in discharge volume is quantifiable.

#### Sediment Discharge Monitoring

Previous literature suggests that the Pawtuxet River may be a suspended load dominated system. This is the classification of a stream in which more sediment is transported in suspension as compared to the quantity not in suspension moving along the bottom. This observation will be evaluated with measurements in Phase I. Depth-integrated suspended sediment samples will be collected in conjunction with the water discharge measurements and submitted for laboratory analysis. Suspended sediment discharge will be determined using the USGS mid-point method. The velocity measurements recorded during water discharge monitoring will be used to calculate bottom shear stress. Bottom shear stress will be compared to the grain size distribution and bulk density of the bed sediment, and the potential of flow moving the bed sediment will be evaluated. Observations made during the hydrologic investigation, including any bed forms recorded during the bathymetric survey, also will be evaluated and presented in both the Phase I Interim Report and the Phase II Proposal. If necessary, bed load transport will be investigated during Phase II of the RFI.

### Bed Sediment Sampling

During the hydrologic investigation, six bed sediment samples will be retrieved from the Pawtuxet River using vertical pipe corers, dredge-type samplers, or scoops (Table 3-3). Vertical pipe corers will be used when practical because they minimize sample disturbance. The samples collected will be inspected to evaluate the thickness and composition of recently deposited river sediment and to determine the preferred method of taking the bed sediment samples for subsequent chemical analysis (see Section 4 - Release Characterization). The proposed bed sediment sampling locations are shown on Figure 3-4.

One bed sediment sample will be collected at the location of the discharge end of each of the five former outfalls. One sample also will be collected at the location of the former over-the-river tank farm (ORTF). The former outfalls and ORTF are discussed in Chapter 1 - Current Assessment Summary Report.

The final locations of bed sediment samples will be determined based on the results of the bathymetric survey and on observations made while working on the river. The location of the outfalls will be confirmed based on the river reconnaissance and the bathymetric survey. Each of the bed sediment samples will be analyzed for physicochemical parameters including: particle size distribution, bulk density, cation exchange capacity, pH, porosity, and total organic carbon. Additional samples and transects may be taken if additional coverage is deemed necessary based on the diversity of bed sediment encountered. Chemistry is planned as detailed in Chapter 3, Section 4.

#### **3.7.4 Methods**

Specific methods applicable to the hydrologic investigation are described Volume 2 - Project Quality Assurance Plan (Section 6). The methods include:

- o bathymetric surveying procedures;
- o water and suspended sediment discharge monitoring methods;

- o bed sediment sampling methods; and
- o particle size distribution, bulk density, ion exchange capacity, pH, porosity, and total organic carbon analyses.

### 3.7.5 Justification

The physical characteristics of the Pawtuxet River have not been investigated in the context of the RFI; the physical characteristics must be understood and quantified in order to evaluate their relationship to the potential movement and transport of Constituents of Concern.

The bathymetric survey is needed to establish appropriate surface water and suspended sediment discharge monitoring stations. River reconnaissance, conducted as part of the bathymetric survey, is needed to help identify the location of former outfalls. The bathymetric survey also may help identify areas of sedimentation associated with the former outfalls.

The water and suspended sediment discharge must be quantified in order to evaluate total loadings, if appropriate, of Constituents of Concern. The physical characteristics of the bed sediment must be quantified in order to evaluate the potential for bed load transport.

The information to be obtained during the hydrologic investigation, together with the information to be collected during the Release Characterization Investigation, is believed to be sufficient to meet the requirements of the Order and associated objectives.

This section described the Physical Site Characterization Study work plan -- Phase IA of the RCRA Facility Investigations. It reviewed four categories of investigations -- geophysical, geologic, hydrogeologic, and hydrologic -- that will characterize the physical environment of the facility. Geophysical investigations include a ground penetrating radar survey, a seismic refraction survey, and an electrical resistivity survey. Geologic investigations include a literature review, a field mapping of bedrock in the site area, and a physical geologic investigation of the immediate facility environment. Hydrogeologic investigations include a

literature review, installing and testing piezometers and bedrock monitoring wells for sustainable ground water flow volumes, and monitoring water levels. The hydrologic investigation includes a literature review, bathymetric surveying, water discharge monitoring, suspended sediment discharge monitoring, and bed sediment sampling.

Data from the Physical Site Characterization will be summarized and a Release Characterization Strategy for Phase IB will be developed. The next section characterizes the nature and extent of past releases from the facility.

## VOLUME 1 - CHAPTER 3

### FACILITY INVESTIGATION WORK PLAN

#### SECTION 4

#### RELEASE CHARACTERIZATION INVESTIGATION (PHASE IB)

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In Phase IA, a Physical Site Characterization Study (previously described in Section 3) was proposed to evaluate the facility's physical environment. At the conclusion of that study, the results will be summarized, and, if appropriate, the Release Characterization Strategy proposed for Phase IB, will be modified. The Release Characterization Investigations will begin after the strategy has been reviewed and approved by the USEPA. An overview of the Physical Site and Release Characterization Investigations is presented in Figure 4-1. Sampling locations and monitoring points that will be used to characterize the facility's environment are shown.

Release Characterization Investigations will be performed to verify suspected releases and to assess the nature and extent of contamination. Sampling strategies for the Release Characterization program are based on the requirements of the Order. In Phase IB, four Media of Concern will be investigated:

- o soil;
- o ground water;
- o surface water; and
- o sediment.

This section discusses the Release Characterization Investigations by study area; sampling programs are presented for the on-site area, the off-site area, and the Pawtuxet River area.



For all sampling events, CIBA-GEIGY will provide for split or duplicate samples to be taken by the USEPA or its authorized representatives. Before a sampling round begins, CIBA-GEIGY or its contractors will give the USEPA 14 calendar days notice. If rescheduling of any sampling event is required, CIBA-GEIGY or its contractors will give the USEPA 10 calendar days notice.

#### 4.1 ON-SITE AREA

Twelve SWMUs, two Areas of Concern, and two Additional Areas of Investigation have been identified at the facility (based on information submitted by CIBA-GEIGY, data gathered by the USEPA including the Facility Assessment, and information collected by CIBA-GEIGY during the Preliminary Investigation). Release Characterization sampling programs have been developed for thirteen of these study areas. Characterization of SWMU-1, SWMU-4, and AOC-14 are not required by the Order, since there is no evidence of any past releases from these areas. For characterization of the on-site area, unit-specific investigations are proposed.

All required Media of Concern will be sampled twice in Phase IB. In Round 1, Media of Concern will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters. In Round 2, all Media of Concern will be resampled to verify the analytical results of Round 1. Additional Round 2 Media of Concern will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters. The Analyte Lists were discussed in Section 2. The Release Characterization program for the on-site area is summarized in Table 4-1. Methods and procedures that will be used are described in Volume 2 - Section 1 - Project Quality Assurance Plan. Descriptions and data requirements for the on-site areas are presented, unit-by-unit, in the following discussion.

For each SWMU, AOC, and AAOI, this section describes the history of the unit and its wastes, previous analytical results pertaining to the unit (if any), and a

release characterization strategy for the unit (as appropriate). In general, the release characterization strategy will include the objectives of the release characterization program for that unit, a conceptual release model that justifies the strategic approach, and the tactics that will be used to implement the strategy.

#### 4.1.1 SWMU-1: Hazardous Waste Storage Area

##### SWMU-1: Unit and Waste History

SWMU-1 was a hazardous waste storage area located southwest of the waste water treatment plant on the Warwick side of the river (see Figure 4-1). SWMU-1 had a maximum storage capacity of 768 55-gallon drums; the unit typically stored 300 to 400 drums at any given time. The hazardous waste storage area was asphalt-lined, diked, and surrounded by a 6-foot high chain link fence; it was 42 feet by 58 feet, with a 32-inch high concrete containment dike capable of holding 48,000 gallons.

SWMU-1 was used from 1981 through 1986 solely for storing various hazardous wastes in drums (including flammable liquids and solids, corrosive liquids and solids, organic mixtures and solids, non-hazardous organic mixtures, and chloroform). SWMU-1 was decommissioned by OH Materials using the standard operating procedures described in the Storage and Treatment Facility Closure Plan (RCRA Part B Permit Application Submission, 1985). Closure of this unit was verified by a professional engineer from Bechtel National Inc. The closure was approved by the Rhode Island Department of Environmental Management (RIDEM) in 1987.

SWMU-1 was decommissioned prior to the on-site sampling investigation. Media of Concern were not sampled from this unit during either the Facility Assessment or the Preliminary Investigation. No evidence of releases were observed by the USEPA contractors during the Facility Assessment sampling

visit. The potential for exposure to any waste previously managed in the unit was considered negligible by the USEPA contractors. Because there are no known releases from this area, investigation of this unit is not required by the Order. SWMU-1 will not be investigated as part of the RFI.

#### **4.1.2 SWMU-2: 6000-Gallon Hazardous Waste Storage Tank**

##### **SWMU-2: Unit and Waste History**

SWMU-2 was a 6000-gallon above ground hazardous waste storage tank located in the tank farm just south of the railroad tracks in the Production Area (see Figure 4-1). The tank stored liquid hazardous waste mixtures generated at the facility including process waste water containing acetone, toluene, monochlorobenzene, isopropanol, naphtha, xylene, heptane, and methanol. The carbon steel vertical tank was 8 feet in diameter and 17 feet high; it was supported by a one-foot thick reinforced concrete slab, and was surrounded by a secondary containment dike with a capacity of 8000 gallons.

Liquid hazardous wastes were transferred regularly from SWMU-2 to railroad cars for off-site disposal. No releases from SWMU-2 were known or suspected during its period of operation. The hazardous waste storage tank, including the pumps and piping associated with loading the tank cars, were inspected regularly. Drainage from the diked enclosure originally flowed to the facility's waste water treatment plant. However, in compliance with federal hazardous waste storage requirements, this drainage line was sealed off; subsequently, water from the sump within the dike was pumped out for off-site disposal.

SWMU-2 was used from 1981 through 1986 (when the facility was decommissioned). Closure of SWMU-2 was performed by OH Materials in 1986 using the standard operating procedures described in the Storage and Treatment Facility Closure Plan (RCRA Part B Permit Application Submission, 1985). Decommissioning of the unit was verified by a professional engineer from Bechtel National Inc. The closure was approved by RIDEM in 1987.

## SWMU-2: Previous Analytical Results

Shallow soil samples were collected for chemical analysis during the Facility Assessment site visit (after the tank was decommissioned and removed from the tank farm area). Split soil samples collected by the USEPA and CIBA-GEIGY in 1987 were taken downslope of SWMU-2. The soil samples contained detectable quantities of volatile and semi-volatile organic compounds and polychlorinated biphenyls (PCBs). Total volatile organic compounds (toluene, methylene chloride, and acetone) were measured at concentrations up to 0.103 ppm. Total semi-volatile compounds (polynuclear aromatic hydrocarbons, or PAHs) were detected at concentrations up to 7.84 ppm. PCB (arochlor-1254) was detected in all three soil samples at concentrations of 0.31 ppm or less. The analytical results of the Facility Assessment soil samples are summarized in Table 6-2 in Chapter 1 - Current Assessment Summary Report. Media of Concern from the tank farm area were not sampled during the Preliminary Investigation.

No releases from SWMU-2 are known or suspected. CIBA-GEIGY believes that trace concentrations of some wastes, stored in the tank farm and found in shallow soils downslope of SWMU-2, resulted from waste water releases in the Production Area (AOC-13) rather than from operation of SWMU-2. No conceptual release model can be developed that will distinguish among releases from SWMU-2, SWMU-3, and AOC-13.

Releases resulting from the transfer of liquid waste to the railroad cars (if any) would not have impacted the surficial soils in the vicinity of the release because the area was paved. Surface water runoff from heavy rains could have transported hazardous waste downslope (toward the river or to the surface runoff collection system).

### SWMU-2: Release Characterization Strategy

The Release Characterization Strategy for SWMU-2 was developed after evaluating the existing analytical data and formulating a conceptual release model. The objectives of the release characterization program for SWMU-2 include:

- o determining if a release from SWMU-2 can be distinguished from an AOC-13 release; and
- o determining the nature, concentration, and extent of contamination released from SWMU-2 (if any).

In Phase IB, soil and ground water will be investigated in the vicinity of SWMU-2 (AOC-13). Soil will be sampled from test pit excavations and soil borings; ground water will be sampled from newly installed and existing monitoring wells. Two sampling rounds will be performed for each Media of Concern.

One test pit (TP-2A) will be excavated at SWMU-2 to evaluate subsurface conditions (see Figure 4-1). Soil samples from test pit TP-2A will be field-screened with an HNu or OVA, but will not be submitted for laboratory analysis. If a zone of visible contamination is observed in the test pit, the adjacent soil boring B-2A will be advanced to that depth and a sample will be collected for laboratory analysis. If no organic vapor or visible contamination is detected during trenching, soil samples from borings will be collected from just above the water table.

In Round 1, soil from three borings will be sampled from the tank farm area (see Figure 4-1). The exact locations of these borings (B2A, B2B, and B2C) will be based on conditions encountered during the test pit excavations. Soil samples will

be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters (Table 4-2). In Round 2, three additional soil samples will be collected from the tank farm area. One boring sample, collected from a location sampled in Round 1, will be used to verify the analytical results of the first sampling round. Two additional borings, advanced downgradient of the tank farm, will be used to characterize further the extent of soil contamination, if any, within this area. Round 2 soil samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

In Round 1, ground water beneath SWMU-2 will be sampled from new and existing monitoring wells. Two new monitoring wells will be installed downgradient of SWMU-2 to determine if ground water has been impacted by past releases (see Figure 4-1). A shallow well (MW-10S) will be screened across the water table to evaluate the water quality of the upper aquifer and to determine if floating liquids are present. A deep well (MW-10D) will be screened just above a confining layer (e.g., clay, till, bedrock) to determine if Dense Non-Aqueous Phase Liquids (DNAPLs) have been released. Ground water samples will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters (Table 4-2).

Monitoring wells sampled in Round 1 will be resampled in Round 2. Round 2 ground water samples will be collected to verify the analytical results from Round 1 and to evaluate the effect of seasonality on ground water. Round 2 ground water samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

#### **4.1.3 SWMU-3: 7500-Gallon, 90-Day Accumulation Tank**

##### **SWMU-3: Unit and Waste History**

The above-ground 7500-gallon accumulation tank was located in the same tank farm as SWMU-2 (see Figure 4-1). The stainless steel accumulation tank was

used to store flammable liquids for periods of less than 90 days. The vertical tank was 8.5 feet in diameter and 17 feet high, and was enclosed (along with three other tanks) by a containment dike having a capacity of 25,000 gallons.

The accumulation tank operated during 1985 and 1986 (until the facility was decommissioned). No releases were known or suspected during the period of operation. Liquid wastes from SWMUs-2 and -3 were pumped into 10,000-gallon railroad cars for weekly shipment to an off-site disposal facility. Approximately 260,000 gallons of wastes were loaded each year.

Closure of SWMU-3 was performed by OH Materials in 1986 using the standard operating procedures described in the Storage and Treatment Facility Closure Plan (RCRA Part B Application Submission, 1985). Decommissioning was verified by a professional engineer from Bechtel National Inc. The closure of SWMU-3 was approved by RIDEM in 1987.

#### SWMU-3: Previous Analytical Results

The analytical results of soil samples taken during the Facility Assessment were discussed earlier (see "SWMU-2: Previous Analytical Results"). Shallow soil samples collected downslope of the tank farm area contained detectable quantities of volatile organic compounds, PAHs, and PCBs. The analytical results of this investigation are summarized in Table 6-2 in Chapter 1 - Current Assessment Summary Report. Media of Concern from the tank farm area were not sampled during the Preliminary Investigation.

No releases from the 90-day accumulation tank are known or suspected. Releases resulting from the transfer of ignitable liquid waste to the railroad cars (if any) would not have impacted the surficial soils in the vicinity of the release because the area was paved. Surface water runoff from heavy rains could have transported ignitable waste downslope (toward the river or to the surface water runoff collection system).

### SWMU-3: Release Characterization Strategy

The Release Characterization Strategy for SWMU-3 was developed after evaluating the existing analytical data and formulating a conceptual release model. The objectives of the release characterization program for SWMU-3 include:

- o determining if a release from SWMU-3 can be distinguished from an AOC-13 release; and
- o determining the nature, concentration, and extent of contamination released from SWMU-3 (if any).

In Phase IB, soil and ground water will be investigated in the vicinity of SWMU-3 (AOC-13). Soil will be sampled from test pit excavations and soil borings; ground water will be sampled from newly installed and existing monitoring wells. Two sampling rounds will be performed for each Media of Concern.

One test pit (TP-3A) will be excavated at SWMU-3 to evaluate subsurface conditions (see Figure 4-1). Soil samples from test pit TP-3A will be field-screened with an HNu or OVA, but will not be submitted to laboratory analysis. If a zone of visible contamination is observed in the test pit, an adjacent soil boring B-2A will be advanced to that depth and a sample will be collected for laboratory analysis. If no organic vapor or visible contamination is detected during trenching, soil samples from borings will be collected from just above the water table.

In Round 1, soil from three borings will be sampled from the tank farm area. (Soil borings B-2A, B-2B, and B-2C are common to both SWMUs-2 and -3. (The



exact locations of these borings will be based on conditions encountered during the test pit excavation.) Soil samples will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters (Table 4-2). In Round 2, three additional soil samples will be collected from borings advanced within the tank farm area. One boring sample, collected from a location sampled in Round 1, will be used to verify the analytical results of the first sampling round. Two additional borings, advanced downgradient of the tank farm, will be used to characterize further the extent of soil contamination (if any) within this area. Round 2 soil samples will also be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

In Round 1, ground water will be collected from newly installed and existing monitoring wells. Two new monitoring wells will be installed downgradient of SWMU-3 to determine if ground water has been impacted by past facility releases (see Figure 4-1). A shallow well (MW-10S) will be screened across the water table to evaluate the water quality of the upper aquifer and to determine if floating liquids are present. A deep well (MW-10D) will be screened just above a confining layer (e.g., clay, till, bedrock) to determine if DNAPLs have been released. (Both monitoring wells are common to SWMU-2 and -3). Ground water samples will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters (Table 4-2).

Monitoring wells sampled in Round 1 will be resampled in Round 2. Round 2 ground water samples will be collected to verify the analytical results of the first Round 1 and to evaluate the effect of seasonality on ground water. Round 2 ground water samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

#### 4.1.4 SWMU-4: Trash Compactor Station

##### SWMU-4: Unit and Waste History

SWMU-4 was a trash compactor station located on a concrete pad (21 feet by 36 feet) north of Building 27 in the Production Area. There were two compactors, of 30 and 55 cubic yards capacity, respectively. The compactors handled packaging material, waste paper, and washed fiber drums. All potentially contaminated surface water from the Production Area, including water that collected in the pad area, was sent to the waste water treatment plant.

There were no known or suspected releases from this area. Any spills from the compactor would have collected at the drainage sump and then flowed to the waste water treatment plant. The trash compactor station was decommissioned prior to conducting the on-site sampling investigations. Media of Concern were not sampled during the Facility Assessment or the Preliminary Investigation. There are no releases from this area, and investigation of this unit is not required by the Order. SWMU-4 will not be investigated as part of the RFI.

#### 4.1.5 SWMU-5: River Sediment Storage Area

##### SWMU-5: Unit and Waste History

SWMU-5 was a storage area for river sediment. In 1971, sediment was dredged from the Pawtuxet River from the reach between the Production Area's pedestrian and vehicular bridges. The sediment was stockpiled in the Warwick Area (see Figure 4-1). Dredging took place as part of the removal of the original cofferdam/waste water outfall. Approximately 6630 cubic yards of sediment were stockpiled until December 1976, when the material was removed from the facility. The area was brought back to grade in 1977 as part of the flood plain restoration required under the Wetlands Act to permit construction of the equalization tanks for CIBA-GEIGY's waste water treatment system. The

sediment occupied an irregularly shaped area. Historical maps and other documents do not provide definitive information about the shape and location of SWMU-5. The river sediments were not chemically analyzed during the dredging and storage operation.

#### **SWMU 5: Previous Analytical Results**

Soil and ground water were sampled from SWMU-5 by the USEPA contractors and by CIBA-GEIGY during the Facility Assessment sampling visit. A summary of the analytical results is presented in Tables 6-1 and 6-2 in Chapter 1 - Current Assessment Summary Report. The analytical results of the split soil samples appear to be inconsistent. Several inorganic compounds identified in USEPA soil sample SS-3 were not detected in the split analyzed by CIBA-GEIGY. Conversely, traces of volatile organic compounds and PAHs identified in the sample taken by CIBA-GEIGY were not detected in the split collected by the USEPA. Ground water samples from piezometer GW-8 contained only trace concentrations of inorganics, volatiles, and semi-volatile compounds.

Soil and ground water samples also were collected from SWMU-5 during the Preliminary Investigation. Five soil samples (4 surficial and 1 shallow) were collected to assess the nature and extent of soil contamination in the area. One ground water sample was collected beneath SWMU-5 to determine if ground water quality has been impacted. The analytical results of this investigation are summarized in Table 6-12 in Chapter 1 - Current Assessment Summary Report.

In SWMU-5, soils up to at least one foot deep contained mainly PAHs and lesser amounts of volatile and semi-volatile compounds. One soil sample (RS-2) contained several inorganic compounds, including zinc at a concentration of 2320 ppm. Constituents of Concern appear to be limited to the near surface soils. A shallow soil sample (taken at a depth of 3 to 5 feet below grade) contained only trace concentrations of four semi-volatile compounds. With the exception of a trace of pesticide (1.4 ppm of methoxychlor), ground water underlying SWMU-5 appears to be clean.

The analytical results of surface soil samples collected during the Preliminary Investigation indicate that residual river sediment contaminants may have migrated from SWMU-5. Four soil samples, collected approximately 30 feet from the assumed source of SWMU-5, contained varying concentrations of TCL analytes. Migration or displacement of soil contaminants may have resulted from excavation of the river sediment storage area, from surface water runoff, or from flooding. Subsurface infiltration to the deeper soil horizons or to the ground water table can not be evaluated adequately from existing monitoring data.

#### SWMU-5: Release Characterization Strategy

The Release Characterization Strategy for SWMU-5 will investigate the volume of river sediments still remaining in this part of the facility and determine if ground water beneath (or downgradient of) SWMU-5 has been impacted. Specifically, the objectives of the release characterization program include:

- o characterizing the nature, concentration, and extent of contamination resulting from past sediment storage practices;
- o determining if Constituents of Concern have migrated or been displaced; and
- o determining if ground water beneath or downgradient of SWMU-5 has been impacted.

In Phase IB, soil and ground water will be investigated in the vicinity of SWMU-5. Soil will be sampled from surficial excavations and shallow-borings; ground water will be sampled from newly installed and existing monitoring wells. Two sampling rounds will be performed for each Media of Concern.

In Round 1, a systematic sampling approach will be used to assess the nature and extent of contaminants within SWMU-5. Prior to sampling, a grid (100 feet x 100 feet) will be established over the area of investigation. Twenty-five sampling nodes will be established along 20 foot grid lines (see Figure 4-2, Inset A). Both surficial (6- to 12-inch depth) and shallow (18- to 24-inch depth) soil samples will be collected at each node. Because sediments stored within the area may have been contaminated with optical brighteners, all soil samples will be field-screened with an ultraviolet lamp as well as with an HNu or OVA. The field test results will be reanalyzed by standard laboratory methods after submitting five samples to a commercial laboratory. Soil samples which exhibit high HNu readings or respond to the ultraviolet lamp will be submitted for laboratory analysis. If soil samples do not respond to the field screening techniques, five samples will be selected randomly for analysis. In Round 1, therefore, a total of five soil samples will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters (Table 4-2).

In Round 2, a total of five additional soil samples will be collected from SMWU-5. One surficial and one shallow soil sample, collected from locations sampled in Round 1, will be used to verify the analytical results of the first sampling round. Three additional soil samples will be collected downslope of SWMU-5 to characterize further the extent of soil contamination in this area. Round 2 soil samples will also be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

In Round 1, ground water will be sampled from new and existing monitoring wells. Two new monitoring wells will be installed downgradient of SWMU-5 to determine if ground water has been impacted by the storage of river sediments (Figure 4-2). A shallow well (MW-11S) will be screened across the water table to evaluate the water quality of the upper aquifer and to determine if floating liquids are present. A bedrock well (RW-3) will be installed 10 feet into rock to monitor the water quality of the bedrock aquifer. Ground water samples from newly installed and existing monitoring well MW-6S will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

Monitoring wells sampled in Round 1 will be resampled in Round 2. Round 2 ground water samples will be collected to verify the analytical results of the first sampling round and to evaluate the effect of seasonality on ground water. Round 2 ground water samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

#### 4.1.6 SWMU-6: Zinc Oxide/Soil Pile

##### SWMU-6: Unit and Waste History

SWMU-6 is a soil pile containing residues of zinc oxide. In the late 1960s, 140,000 pounds of zinc oxide spilled from a broken rail car that was on the siding near Buildings 32 and 33 in the Warwick Area. The zinc oxide was transferred to another rail car. The spilled zinc oxide was cleaned up, and paved areas were swept as part of normal plant maintenance. After the spill, road sweepings from in and around the railroad spur in the Warwick Area contained some zinc oxide residue. Those sweepings were used to form a drainage berm now identified as SWMU-6.

The soil berm was not removed during decommissioning activities and remains stored on-site at its original location. The soil pile, approximately 50 feet long by 7 feet wide by 2 feet high, contains about 25 cubic yards of material. The pile contains about 10 percent zinc oxide and can be identified by the lack of vegetative growth.

##### SWMU-6: Previous Analytical Results

Media of Concern from SWMU-6 were not investigated during the Facility Assessment sampling visit. However, soil was sampled from SWMU-6 as part of the Preliminary Investigation. Note that the location of soil sample RS-5 was misidentified in the Order: soil sample RS-5 was collected from SWMU-6, not

from SWMU-9.

The analytical results of soil sample RS-5 are summarized in Tables 6-6 and 6-12 in Chapter 1 - Current Assessment Summary Report. The revised sampling location is shown in Figure 6-1 in Chapter 1. The composite soil sample contained a variety of volatile and semi-volatile organic compounds (up to 8.95 ppm total organic Appendix IX compounds). Most of the identified organic compounds were detected in concentrations below the laboratory quantification limits. Zinc was detected at a concentration of 24,600 ppm (approximately 2.4 percent of the sample).

Constituents of Concern may have migrated from SWMU-6. Surface water runoff from heavy rains may have transported potential contaminants downslope toward the river. Zinc or other soil contaminants may have infiltrated into the deeper soil horizons. Constituents of Concern may have infiltrated or leached into the ground water by intermedia transport.

#### SWMU-6: Release Characterization Strategy

The Release Characterization Strategy for SWMU-6 will examine the nature of contaminants within the waste pile and determine if Constituents of Concern have migrated from SWMU-6. The objectives of the release characterization program for SWMU-6 include:

- o determining the nature and concentration of Constituents of Concern within the zinc oxide/soil pile; and
- o determining the extent to which Constituents of Concern may have migrated from SWMU-6.

In Phase IB, only soil will be investigated from SWMU-6. Two rounds of soil sampling will be performed. In Round 1, one sample will be collected from the

center of the pile and analyzed for Appendix compounds, fingerprint compounds, major ions, and treatability parameters (Table 4-2).

In Round 2, six additional samples will be collected from SWMU-6. One sample, collected from the location sampled in Round 1, will be used to verify the analytical results of the first sampling round. Five additional surficial samples, collected downslope of SWMU-6, will be used to characterize the extent of soil contamination in this area. Round 2 soil samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

#### 4.1.7 SWMU-7: Chlorosulfonic Acid Spill Area

##### SWMU-7: Unit and Waste History

SWMU-7 is an area (about 10 feet wide by 20 feet long) where, in 1961, approximately 500 gallons of chlorosulfonic acid were spilled from a trailer truck (see Figure 4-1). Soils within the spill area were neutralized and subsequently excavated to accommodate new tank farm foundations in the Production Area. Little more is known about the chlorosulfonic acid release at SWMU-7. For example, it is not known what was used to neutralize the spill or how much soil was removed.

##### SWMU-7: Previous Analytical Results

Media of Concern from SWMU-7 were not investigated during the Facility Assessment or the Preliminary Investigation. Because this area was excavated, covered with a tank farm, and then decommissioned, evidence of the release could not be documented. Since no analytical data exist for this release, it will be investigated as part of the RFI.

Prior to excavation, acid constituents may have infiltrated or leached into



the deeper soil horizons or into the ground water. Constituents of Concern also may have migrated along preferential pathways.

#### SWMU-7: Release Characterization Strategy

The Release Characterization Strategy for SWMU-7 will determine if residual contaminants remain in the impacted area. The objectives of the release characterization program for SWMU-7 include:

- o determining if all impacted soils were excavated; and
- o determining the nature, concentration, and extent of the remaining impacted soils (if any).

The release characterization program developed for SWMU-7 is similar to that developed for SWMUs-2 and -3 in the main tank farm area. In Phase IB, soil and ground water from SWMU-7 will be investigated. Soil will be sampled from a test pit excavation and soil borings; ground water will be sampled from newly installed and existing monitoring wells. Two sampling rounds will be performed for each Media of Concern.

Subsurface conditions beneath SWMU-7 will be evaluated using a test pit (TP-7A) excavation (see Figure 4-1). Soil samples from TP-7A will be field screened with an HNu or OVA, but will not be submitted to laboratory analysis. If a zone of visible contamination is observed in the test pit, the adjacent boring B-7A will be advanced within that zone and a soil sample will be collected for laboratory analysis. If no organic vapor or visible contamination is detected during trenching, soil samples from borings will be collected from just above the water table.

In Round 1, soil from two borings will be sampled from SWMU-7 (see Figure 4-1). The exact locations of the borings (B-7A and B-7B) will be based on conditions encountered during the test pit excavation. Soil samples will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters (Table 4-2).

In Round 2, two additional soil samples will be collected from SWMU-7. One boring sample, collected from a location sampled in Round 1, will be used to verify the analytical results of the first sampling round. One additional boring, advanced downgradient of SWMU-7, will be used to characterize the extent of soil contamination in this area. Round 2 soil samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

In Round 1, ground water will be sampled from one new and one existing monitoring well. One new monitoring well will be installed downgradient of SWMU-7 to determine if ground water has been impacted by SWMU-7 (see Figure 4-1). The new shallow well (MW-12S) will be screened across the water table to evaluate the water quality of the upper aquifer and to determine if floating liquid is present. Ground water samples from MW-12S and existing monitoring well MW-4S will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters (Table 4-2).

The monitoring wells sampled in Round 1 will be resampled in Round 2. Round 2 ground water samples will be collected to verify the analytical results of the first sampling (Round 1) and to evaluate the effect of seasonality on ground water. Round 2 ground water samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

#### **4.1.8 SWMU-8: Prussian Blue Spill Area**

##### **SWMU8: Unit and Waste History**

Blue stained soil was excavated in 1961 while constructing the foundation for the new tank farm. Approximately 300 cubic yards of soil were removed and replaced with new fill for the storage tank foundation. No information exists regarding the release at SWMU-8. However, it is believed that the blue soil was first noticed around 1956. Laboratory analysis to confirm the presence of Prussian Blue was not performed. Reports of the incident, including the method used to determine the report of the release, are no longer available.

In the 1960s, during the installation of the waste water piping system another quantity of blue stained soil was excavated just east of Building 24. It is not known to where the excavated materials were removed.

##### **SWMU-8: Previous Analytical Results**

Media of Concern for SWMU-8 were not investigated during the Facility Assessment or the Preliminary Investigation. Because this area was paved, evidence of a release could not be documented during the Facility Assessment visit. Prior to excavation, Constituents of Concern may have infiltrated or leached into the deeper soil horizons or into the ground water. The Prussian Blue also may have migrated along preferential pathways.

##### **SWMU-8: Release Characterization Strategy**

The Release Characterization Strategy for SWMU-8 will determine if residual contaminants remain in the impacted area. The objectives of the release characterization program for SWMU-8 include:

- o determining if all impacted soils were excavated; and

- o determining the nature, concentration, and extent of impacted soils (if any).

In Phase IB, soil and ground water will be investigated from SWMU-8. Soil will be sampled from a test pit excavation and soil borings; ground water will be sampled from newly installed and existing monitoring wells. Two sampling rounds will be performed for each Media of Concern.

Subsurface conditions beneath SWMU-8 will be evaluated using a test pit (TP-8A) excavation (see Figure 4-1). Soil samples from test pit TP-8A will be screened with an HNu or OVA, but will not be submitted for laboratory analysis. If a zone of visible contamination is observed in the test pit, an adjacent boring B-8A will be advanced to that depth and a sample will be collected for laboratory analysis. If no visible contamination is detected during trenching, soil samples from borings will be collected from just above the water table.

In Round 1, soil from two borings will be sampled from SWMU-8 (see Figure 4-1). The exact locations of the borings (B-8A and B-8B) will be based on conditions encountered during the test pit. Soil samples will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

In Round 2, two additional soil samples will be collected from SWMU-8. One boring sample, collected from a location sampled in Round 1, will be used to verify the analytical results of the first sampling round. One additional boring, advanced downgradient of SWMU-8, will be used to characterize the extent of soil contamination in this area. Round 2 soil samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

In Round 1, ground water will be sampled from a new and an existing monitoring well. One new monitoring well will be installed downgradient of SWMU-8 to determine if ground water has been impacted by the Prussian Blue spill. The new shallow well (MW-13S) will be screened across the water table to evaluate the water quality of the upper aquifer and to determine if floating liquid is present. Ground water samples from MW-13S and existing monitoring well MW-3S will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

The monitoring wells sampled in Round 1 will be resampled in Round 2. Round 2 ground water samples will be collected to verify the analytical results of Round 1 and to evaluate the effect of seasonality on ground water. Round 2 ground water samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

#### **4.1.9 SWMU-9: Waste Water Pipeline Break - Warwick Area**

##### **SWMU-9: Unit and Waste History**

SWMU-9 was the site of a waste water pipeline break in the Warwick Area. On 12 January 1982, a break in the main raw waste water transfer pipeline (on the Warwick property) leading to the facility's waste water treatment plant resulted in a discharge to the Pawtuxet River (see Figure 4-1). Remedial measures were taken to reduce flow in the line and permit repairs. Approximately 24,000 gallons of raw waste escaped over a four hour period. The raw waste entered the surface water runoff catchment system and discharged into the Pawtuxet River via Outfall Number 004.

Laboratory analysis of the material spilled or the media impacted was not performed after the release. The influent to the waste water treatment plant typically contained halogenated and non-halogenated solvents and other organic

compounds (e.g., materials routinely used in the chemical manufacturing process). The pH of the treatment plant's effluent normally varied from 4 to 12. The pH of the river both upstream and downstream of the spill's entry was measured by CIBA-GEIGY personnel; both readings had a pH of 6. The spill resulted in a period of bypass as defined in the facility's NPDES permit.

#### **SWMU-9: Previous Analytical Results**

Analytical data characterizing the nature and extent of this release were not collected in previous investigations. Media of Concern were not collected from SWMU-9 during either the Facility Assessment or the Preliminary Investigation. The area surrounding the pipeline break displayed no evidence of the release at the time of the Facility Assessment sampling visit. The impact on soil in SWMU-9 is not known. Constituents of Concern may have infiltrated or leached into the soil or ground water prior to discharging into the river. Migration of potential contaminants also may have resulted from surface water runoff.

#### **SWMU-9: Release Characterization Strategy**

The Release Characterization Strategy for SWMU-9 will identify impacted soils and determine if Constituents of Concern migrated into the Pawtuxet River. Specifically, the objectives of the release characterization program for SWMU-9 include:

- o characterizing the nature, concentration, and extent of contamination resulting from the pipeline break;
- o determining if Constituents of Concern have migrated; and,
- o determining if the Pawtuxet River has been impacted by SWMU-9.

Ground water will not be investigated at SWMU-9 during the Facility

Investigation. Because the pipeline break occurred on the surface near the bank of the Pawtuxet River, it is unlikely that ground water has been impacted. The river investigation (described in Section 4.3) has been designed to ensure that surface water and sediment near the release area will be investigated.

In Phase IB, soil, surface water, and sediment will be investigated from SWMU-9. Soil will be collected from surficial excavations (6- to 12-inch depth). Surface water and sediment will be collected from the Pawtuxet River. (The scope of the river investigation is described in Section 4.3.) Two sampling rounds will be performed for the soil investigation.

Prior to sampling in Round 1, a grid (60 feet by 60 feet) will be established over the area of investigation. Nine sampling nodes (see Figure 4-2, Inset B) will be positioned along 20-foot grid lines in a 3 x 3 matrix. Surficial soil samples will be collected at each node. All soil samples will be field screened with an HNu or OVA and an ultraviolet lamp. The field tests will be verified with laboratory analysis of three samples. Soil samples exhibiting high HNu readings or responding to the ultraviolet lamp will be submitted for laboratory analysis. If soil samples do not respond to the field screening techniques, samples will be selected randomly for analysis. Soil samples will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

In Round 2, three additional surficial soil samples will be collected from SWMU-9. One soil sample, collected from a location sampled in Round 1, will be used to verify the analytical results of the first sampling round. Two soil samples will be collected downslope of SWMU-9 to characterize further the extent of soil contamination within this area. Round 2 soil samples from both rounds will also be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

#### **4.1.10 SWMU-10: Waste Water Pipeline Break-Waste Water Treatment Area**

##### **SWMU-10: Unit and Waste History**

SWMU-10 was the site of a waste water pipeline break in the Waste Water Treatment Area. On 7 September 1983, an underground pipeline feeding one of three equalization tanks ruptured (see Figure 4-1). Pre-treated neutralized waste water from the equalization tanks normally passed through a clarifier before discharging to the Cranston publically owned treatment works (POTW). The break occurred at a "Y" splice located before the equalization tanks and five feet below the ground surface. About 40,000 gallons of waste water escaped in the 50-minute period before the flow could be shut off. The discharge flowed east, around the 1.5 million gallon equalization tank, into a small pond and then was diverted to the Pawtuxet River via Outfall 005.

The pH of the released waste water was 8.5; the chemical oxygen demand (COD) was 1010 ppm. This discharge contained the following estimated quantities: acetone (31 pounds), isopropyl alcohol (45 pounds), toluene (7 pounds), xylene (1.7 pounds), zinc (0.25 pounds), and nitrobenzene (0.125 pounds). On the day of the release, surface water samples of the river were collected by RIDEM. Toluene was detected in both the upstream (1.1 ppm) and downstream (2.0 ppm) samples.

##### **SWMU-10: Previous Analytical Results**

The impact on the soil and ground water in the release area was examined as part of the Preliminary Investigation. Soil and ground water samples were collected to assess the nature and extent of Constituents of Concern in the release area. The analytical results of this investigation are summarized in Tables 6-6 and 6-11 in Chapter 1 - Current Assessment Summary Report; sampling locations are shown in Figure 6-1 in Chapter 1.



Subsurface soil samples (MW-7 and MW-9) taken from the release area and downgradient of the pipe break contained various volatile and semi-volatile compounds in trace concentrations. Volatiles and semi-volatiles also were detected in trace concentrations in the ground water collected beneath SWMU-10. Downgradient of the spill, ground water sample MW-7 appeared to be clean except for a trace of bis (2-ethylhexyl) phthalate (4 ppb).

Leakage from the line would have impacted the subsurficial soils in the vicinity of the release. Constituents of Concern may have infiltrated into the deeper soil horizons before discharging into the pond. Infiltration or leaching into the ground water by intermedia transport also is possible.

#### SWMU-10: Release Characterization Strategy

The Release Characterization Strategy for SWMU-10 will determine the impact of the waste water pipeline break on soil, ground water, surface water, and sediment. Specifically, objectives of the release characterization program for SWMU-10 include:

- o verifying previous analytical results;
- o determining the nature and extent of Constituents of Concern released from the pipeline break; and
- o determining the impact of the release on the Pawtuxet River and the pond in the Waste Water Treatment Area.

In Phase IB, soil, ground water, surface water, and sediment will be investigated from SWMU-10. Soil samples will be collected from a test pit excavation and soil borings; ground water will be sampled from existing monitoring wells and from one newly installed bedrock well (RW-2). Sediment and surface water samples will be collected from the pond located in the Waste Water

Treatment Area. (The scope of the river investigation is described in Section 4.3.) Two sampling rounds will be performed for each Media of Concern.

Because soil within the spill area was regraded during decommissioning, surficial sampling of the soil will not be performed. One test pit (TP-10A) will be excavated at SWMU-10 to evaluate subsurface conditions (see Figure 4-1). Soil samples from TP-10A will be screened with an HNU or OVA, but will not be submitted for laboratory analyses. If a zone of visible contamination is observed in the test pit, an adjacent soil boring will be advanced to that depth and a sample will be collected for laboratory analysis. If no organic vapor or visible contamination is detected during trenching, soil samples from borings will be collected from just above the water table.

In Round 1, soil from the three borings will be collected from SWMU-10 (see Figure 4-1). The exact locations of the borings (B-10A, B-10B, and B-10C) will be based on conditions encountered during the test pit excavation. Soil samples will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters (Table 4-2).

In Round 2, three additional soil samples will be collected from SWMU-10. One boring, collected from the location sampled in Round 1, will be used to verify the analytical results of the first sampling round. Two additional borings will be advanced downgradient of SWMU-10 to characterize further the extent of soil contamination in this area. Round 2 soil samples will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

In Round 1, ground water samples will be collected from the existing monitoring wells and from one newly installed bedrock well. Existing monitoring wells MW-7S, MW-8S, and MW-9S are shallow wells that are screened across the water table. Samples will be collected from these wells to evaluate the water quality of the upper aquifer and to determine if floating liquid is present. One bedrock well (RW-2) will be installed 10 feet into rock to monitor the water

quality of the bedrock aquifer. Ground water samples will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

The monitoring wells sampled in Round 1 will be resampled in Round 2. Round 2 ground water samples will be collected to verify the analytical results of Round 1 and to evaluate the effect of seasonality on ground water. Round 2 ground water samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

In Round 1, two sediment samples and one surface water sample will be collected from the pond located in the northeast corner of the Waste Water Treatment Area. The pond samples will be used to determine if any residual contamination remains in the pond. Surface water and sediment sampled will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

Sediment and surface water samples from the pond in the Waste Water Treatment Area will be resampled in Round 2. Round 2 samples will be used to verify the analytical results of Round 1. Round 2 sediment and surface water samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

#### **4.1.11 SWMU-11: Toluene Waste Water Release**

##### **SWMU-11: Unit and Waste History**

SWMU-11 was a subsurface sump beneath Building 11 from which toluene was released. Building 11, a facility production building, was razed in October 1983 (see Figure 4-1). During demolition, ground water samples taken from beneath the building's sump contained low concentrations (less than 1 ppm) of toluene. The subsurface sump -- SWMU-11 -- was made of concrete, had a capacity of 300

gallons, and functioned as an overflow reservoir. CIBA-GEIGY estimated that the toluene loss was between 9 and 90 pounds (based on normal building flow conditions and the probable concentration of toluene in the waste stream). Toluene was a primary organic solvent used in the facility's manufacturing processes.

#### SWMU-11: Previous Analytical Results

In previous investigations, Media of Concern were analyzed to characterize the extent of this release. During the Facility Assessment, ground water was sampled from five piezometers located throughout the Production Area. In the vicinity of SWMU-11 as well as downgradient of the release, both soil and ground water were sampled during the Preliminary Investigation. The results of these investigations are summarized in Tables 6-1 and 6-8 in Chapter 1 - Current Assessment Summary Report; sampling locations are shown in Figure 6-1 in Chapter 1.

Ground water samples collected during the Facility Assessment contained volatile and semi-volatile organic compounds. Downgradient of SWMU-11, toluene was detected in ground water sample GW-5 at a concentration of 27 ppb. Soil sample MW-4, taken just above the water table, contained volatile and semi-volatile organic compounds in trace concentrations. The ground water sample (MW-4) also contained volatile organic compounds. Toluene was detected in this sample at a concentration of 39,000 ppb. Other subsurface soil samples taken downgradient of SWMU-11 contained volatile organic compounds and PAHs. Ground water samples from the downgradient wells contained volatile organic compounds (in concentrations up to 60,300 ppb) and semi-volatile organic compounds in trace concentrations.

Leakage from the sump would have impacted the subsurficial soils in the vicinity of the release. Constituents of Concern may have infiltrated to the deeper soil horizons or migrated along preferential pathways. Infiltration or leaching into ground water by intermedia transport is also possible.

### SWMU-11: Release Characterization Strategy

The Release Characterization Strategy for SWMU-11 will identify impacted soils and determine if Constituents of Concern have migrated to ground water. Specifically, the objectives of the release characterization program for SWMU-11 include:

- o determining the nature, concentration, and extent of all impacted soils; and
- o determining if the Constituents of Concern have migrated from the release area.

In Phase IB, SWMU-11 soil and ground water will be investigated. Soil will be sampled from a test pit excavation and soil borings; ground water will be sampled from a newly installed monitoring well and from existing monitoring wells. Two sampling rounds will be performed for each Media of Concern.

One test pit (TP-11A) will be excavated to evaluate the subsurface conditions beneath SWMU-11 (see Figure 4-1). Soil samples from TP-11A will be field-screened with an HNu or OVA, but will not be submitted to laboratory analysis. If a zone of visible contamination is observed in the test pit, an adjacent boring B-11A will be advanced to that depth and a sample will be collected for laboratory analysis. If no organic vapor or visible contamination is detected during trenching, soil samples from borings will be collected from just above the water table.

In Round 1, soil from two borings (B-11A and B-11B) will be collected from SWMU-11 (see Figure 4-1). The exact locations of the borings will be based on conditions encountered during the test pit excavations. Soil samples will be analyzed for the Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

In Round 2, two additional soil samples will be collected from SWMU-11. One boring, collected from a location sampled in Round 1 borings, will be used to verify the analytical results of Round 1. Another boring will be advanced downgradient of SWMU-11 to characterize further the extent of soil contamination in this area. Round 2 soil samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

In Round 1, ground water samples will be collected from a newly installed monitoring well and from existing monitoring wells. A new monitoring well (MW-14S) will be installed downgradient of SWMU-11 to determine if ground water has been impacted by SWMU-11 (see Figure 4-1). The shallow well will be screened across the water table to evaluate the water quality of the upper aquifer and to determine if floating liquid is present. The Round 1 ground water samples will be analyzed for Appendix IX compounds, fingerprints compounds, major ions, and treatability parameters (Table 4-2).

The monitoring wells sampled in Round 1 will be resampled in Round 2. Round 2 ground water samples will be used to verify the analytical results of Round 1 and to evaluate the effect of seasonality on ground water. Round 2 ground water samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

#### **4.1.12 SWMU-12: Waste Water Treatment Area**

##### **SWMU-12: Unit and Waste History**

A waste water treatment plant, SWMU-12, was used during facility operations to treat large volumes of waste water and to minimize the environmental impact of water discharged to the Pawtuxet River (see Figure 4-1). CIBA-GEIGY was issued a NPDES permit (RI 0001171) in 1974 to construct and operate the plant.

SWMU-12 began operation in November 1975 and continued through July 1983 under the limitations of the federal Clean Water Act. In July 1983, CIBA-GEIGY was connected to the Cranston POTW. After the tie-in, process water was pre-treated and analyzed before being discharged to the city's POTW. SWMU-12 operated until the facility was decommissioned and razed in 1986.

Releases of waste water from the treatment facility occurred occasionally before the tie-in to the Cranston POTW was complete. Biological trickling towers were used at the facility from 1970 until 1983. Occasional sump overflows from these towers resulted in discharges to the river. Influent to the trickling towers routinely contained volatile and semi-volatile organic compounds. Additional releases from SWMU-12 also have been documented, including discharges that exceeded the NPDES permit requirements. Discharges exceeding the permitted maximum have been reported for zinc, BOD, and phenols. For two releases, compounds not authorized by the NPDES permit (e.g., chloroform) were discharged to the river.

#### SWMU-12: Previous Analytical Results

Only one ground water sample (GW-6) was collected from SWMU-12 during the Facility Assessment sampling visit. That downgradient sample was collected in the southwestern part of the property along the river bank (Figure 6-1 in Chapter 1 - Current Assessment Summary Report). The analytical results of ground water sample GW-6 are presented in Table 6-1 in Chapter 1. Except for traces of methylene chloride (4 ppb) and xylene (11 ppb), this ground water sample did not contain Constituents of Concern.

Soil and ground water samples were collected from SWMU-12 during the Preliminary Investigation. Three soil samples (MW-7, MW-8, and MW-9) were collected to determine if soil within the Waste Water Treatment Area has been impacted by SWMU-12 (Figure 6-1 in Chapter 1 - Current Assessment Summary Report). Two of these samples were collected downslope of SWMU-12 (along the

northern bank of the river). The third sample was collected upslope (near the 1.5 million gallon equalization tank). Analytical results indicated trace levels of volatile and semi-volatile organic compounds in all three soil samples. Ground water samples were collected from these monitoring wells to evaluate ground water quality in this area. The analytical results are presented in Table 6-11 in Chapter 1. Volatile and semi-volatile organic compounds were detected in all three monitoring wells. In particular, sample MW-8S contained 10,000 ppb of methylene chloride.

Periodic sump overflows from the trickling towers would have impacted the surficial soils in the vicinity of SWMU-12. Constituents of Concern may have migrated into the Pawtuxet River, or may have infiltrated to deeper soil horizons. Infiltration or leaching into the ground water by intermedia transport also is possible.

#### SWMU-12: Release Characterization Strategy

The Release Characterization Strategy for SWMU-12 was developed after evaluating the existing analytical data and formulating a conceptual release model. The objectives of the release characterization program for SWMU-12 include:

- o verifying previous analytical results from SWMU-12;
- o determining the nature, concentration, and extent of Constituents of Concern that were released from SWMU-12; and
- o determining if the Pawtuxet River has been impacted by SWMU-12.

In Phase IB, soil, ground water, sediment, and surface water will be investigated from SWMU-12. Soil will be sampled from shallow soil borings. Ground water will be sampled from newly installed and existing monitoring wells.



The scope of the river investigation is described in Section 4.3. Two sampling rounds will be performed for each Media of Concern.

Prior to sampling in Round 1, a grid (60 feet by 60 feet) will be established over the area of investigation in a 3 x 3 matrix (see Figure 4-2, Inset C). Nine sampling nodes will be established along 30-foot grid lines. At each node, shallow borings will be advanced and soil will be sampled. Soil, taken at depths of 6-24 inches, will be sampled from beneath the paved and unpaved areas. All soil samples will be field screened; selected samples will be submitted for laboratory analysis.

Two soil samples will be collected at each sampling node. One sample will be field screened for volatile organic compounds with an HNu or an OVA. The other sample will be collected for laboratory analysis. Four of the nine samples which exhibit high instrument readings will be submitted for laboratory analysis. If soil samples do not respond to the field screening, samples will be selected randomly for analysis. The four samples selected will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters (Table 4-2). Additional soil from each sampling location may be collected to provide the sample volume necessary for the required analysis.

In Round 1, ground water samples will be collected from newly installed and existing monitoring wells in the Waste Water Treatment Area. Three new monitoring wells will be installed downgradient of SWMU-12 to determine if ground water has been impacted by SWMU-12 (see Figure 4-2). A shallow well (MW-15S) will be screened across the water table to evaluate the water quality of the upper aquifer and to determine if floating liquid is present. A deep well (MW-15D) will be screened just above a confining layer (e.g., clay, till, bedrock) to evaluate the presence of DNAPLs. A bedrock monitoring well (RW-2) will be installed to evaluate ground water quality of the bedrock aquifer. Ground water samples also will be taken from existing wells MW-7 and MW-8. Ground water samples will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

In Round 2, four additional soil samples will be collected from SWMU-12. Two samples, collected from borings advanced in Round 1, will be used to verify the analytical results of the first sampling round. The analytical results of soil samples with little or no contamination will be verified. The other two samples will be collected from locations which characterize further the extent of soil contamination in this area. Round 2 soil samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

Monitoring wells sampled in Round 1 will be resampled in Round 2. Round 2 ground water samples will be collected to verify the analytical results of Round 1 and to evaluate the effect of seasonality on ground water.

#### **4.1.13 AOC-13: Process Building Area**

##### **AOC-13: Unit and Waste History**

Chemical manufacturing took place at the site from 1930 to 1986. Alrose Chemical Company, Geigy Chemical Company, and CIBA-GEIGY Corporation owned and operated chemical manufacturing operations during that time. Only limited information is available about the operations and processes conducted by Alrose Chemical and Geigy Chemical. Most of the chemical manufacturing operations were located in the southern half of the Production Area (see Figure 4-1). This entire area has been identified as AOC-13. All of the structures in this area have been razed and much of the area has been regraded.

##### **AOC-13: Previous Analytical Results**

Media of Concern were not analyzed specifically for AOC-13 during either the Facility Assessment sampling visit or the Preliminary Investigation. However, because SWMUs-2, -3, -4, -7, -8, and -11 are located within AOC-13, previous results from these SWMUs represent AOC-13 conditions.

##### **AOC-13: Release Characterization Strategy**

In order to develop a Release Characterization Strategy for AOC-13, the area of investigation will include the entire Production Area south of the railroad line. (AOC-13 also will be addressed in the discussion of the off-site release characterization.)

The objective of the release characterization for AOC-13 is to determine if Constituents of Concern released during facility manufacturing operations, if any, have settled to the surficial soils and/or infiltrated to deeper soil horizons or ground water. AOC-13 includes SWMUs-2, -3, -4, -7, -8, and -11, and it is unlikely that any Constituents of Concern detected in AOC-13 could be attributed to any specific Production Area SWMU, individually or in concert. The monitoring program for AOC-13 will be satisfied by the sum of the monitoring programs for all of these SWMUs, and by the sampling of monitoring wells (not associated with specific SWMUs), and by the surficial soil sampling program proposed for AOC-13. The scope of this work for AOC-13 is summarized here.

In Round 1, ten soil samples will be collected from the soil borings advanced as part of the monitoring programs for the Production Area SWMUs (see Figure 4-1). In Round 2, ten additional soil samples will be collected from the soil borings in the Production Area SWMUs. Round 2 soil samples will be used to verify the analytical results on the first sampling round and to characterize further the extent of soil contamination within this area. Soil samples from both rounds will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

In Round 1, eleven ground water samples will be collected both from existing and from newly installed monitoring wells (see Figure 4-1). Ground water samples will be analyzed for the Constituents of Concern listed in Table 4-2.

Monitoring wells sampled in Round 1 will be resampled in Round 2. Round 2 ground water samples will be collected to verify the results of Round 1 and to evaluate the effect of seasonality on ground water. Ground water samples from both rounds will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

The release characterization strategy for AOC-13 (which includes SWMU-2, 3, 7, 8 and 11) will also include sampling of surficial soils within the Production Area.

Because soil within the Production Area may have been displaced during decommissioning of the facility, a systematic sampling approach will be used to evaluate soil quality of surficial soil within AOC-13.

In Phase IB, two sampling rounds will be performed during the surficial soil investigation.

Prior to sampling in Round 1, a grid will be established over the area of investigation. The grid established for the GPR survey will be utilized (see Figure 4-2A). Approximately 60 sampling nodes will be positioned along 50-foot grid lines. Surficial soil samples (taken at depths of 6- to -12 inches) will be collected at each node. Soil beneath paved areas will not be sampled. All soil samples will be field screened with an HNu or OVA. The field test will be verified with laboratory analysis of 10 samples. Soil samples exhibiting high instrument readings will be re-submitted for analysis. If soil samples do not respond to the field screening techniques, samples will be selected randomly for analysis. Soil samples will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters (Table 4-2).

In Round 2, 10 additional surficial soil samples will be collected from AOC-13 using the same collection procedures as described above. All soil samples will be field screened with an HNu or OVA. Three locations sampled in Round 1 will be re-sampled in Round 2. Constituents of Concern detected in Round 1 will be verified in Round 2. Seven additional soil samples will be collected 20 feet downslope from the seven samples in Round 1 having the highest HNu/OVA readings, to characterize further the extent of soil contamination within this area. Round 2 soil samples will also be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

#### 4.1.14 AOC 14: Atlantic Tubing and Rubber Company Property

##### AOC 14: Unit and Waste History

In 1981, CIBA-GEIGY purchased 23 acres of property adjoining the site in Cranston, Rhode Island from the Atlantic Tubing and Rubber Company. This property, AOC-14, is located to the west of the Production Area (see Figure 4-1.) All buildings on the AOC-14 property were razed but CIBA-GEIGY did not use or redevelop the land. CIBA-GEIGY has no records of any hazardous waste usage/management activities conducted by the Atlantic Tubing and Rubber Company. Because there are no known releases from this area, investigation of AOC-14 is not required by the Order. AOC-14 will not be investigated as part of the RFI.

#### 4.1.15 AAOI-15: Laboratory Building Waste Water Sump

##### AAOI-15: Unit and Waste History

AAOI-15 is a waste water sump located in the northern part of the Production Area near Building 20 (see Figure 4-1). The gravity sump was used during normal operations in the laboratory building, and drained to sanitary sewer lines that discharged to the Cranston POTW. Design information about the sump is not available currently.

##### AAOI-15: Previous Analytical Results

Media of Concern for AAOI-15 were not investigated during either the Facility Assessment sampling visit or the Preliminary Investigation. Leakage from the sump would have impacted the subsurficial soils in the vicinity of AAOI-15. Constituents of Concern may have infiltrated to the deeper soil horizons or may have migrated along preferential pathways. Infiltration or leaching into the ground water by intermedia transport also is possible.

### AAOI-15: Release Characterization Strategy

The Release Characterization Strategy for AAOI-15 will determine the impact that releases from the sump (if any) may have had on soil and ground water. The objectives of the release characterization program for AAOI-15 include:

- o determining if Constituents of Concern were released from the waste water sump; and
- o determining the nature, concentration, and extent of the Constituents of Concern released (if any).

In Phase IB, soil and ground water from AAOI-15 will be investigated. Soil will be sampled from soil borings; ground water will be sampled from newly installed and existing monitoring wells. Two sampling rounds will be performed for each Media of Concern.

In Round 1, one boring (B-15A) will be advanced beneath AAOI-15 and a soil sample will be collected from just above the water table (see Figure 4-1). In Round 2, two additional boring samples will be collected from AAOI-15. One sample collected from the location sampled in Round 1, will be used to verify the analytical results of the first sampling round. An additional boring, advanced downgradient of the sump, will be used to characterize further the extent of soil contamination, if any, within this area. Soil samples from both rounds will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

In Phase IB, ground water samples will be collected from newly installed and existing monitoring wells. Two new monitoring wells will be installed downgradient of AAOI-15 to determine if ground water has been impacted by

known past releases (see Figure 4-1). A shallow well (MW-16S) will be screened across the water table to evaluate the water quality of the upper aquifer and to determine if floating liquid is present. A deep well (MW-16D) will be screened just above a confining layer (e.g., clay, till, bedrock) to evaluate the presence of DNAPLs. Ground water samples will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters (Table 4-2).

Monitoring wells sampled in Round 1 will be resampled in Round 2. Round 2 ground water samples will be collected to verify the analytical results of the first sampling round and to evaluate the effect of seasonality on ground water. Round 2 ground water samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

#### 4.1.16 AAOI-16: Maintenance Department Cleaning Area

##### AAOI-16: Unit and Waste History

The maintenance department cleaning area -- AAOI-16 -- was located near the southwest corner of former Building 23 (see Figure 4-1). Production machinery (such as portable filters) was brought to this area and steam cleaned. Rinse water was not collected (or analyzed) and probably drained to the nearby surface water catch basin.

##### AAOI-16: Previous Analytical Results

Media of Concern from AAOI-16 were not investigated during either the Facility Assessment sampling visit or the Preliminary Investigation. Surficial soils in the vicinity of AAOI-16 would not have been impacted by the release of Constituents of Concern because the area was paved. Surface water runoff from heavy rains could have transported Constituents of Concern downslope toward the surface water collection system.



## AAOI-16: Release Characterization Strategy

The Release Characterization Strategy for AAOI-16 will determine if past steam cleaning operations impacted subsurface soils or ground water. The objectives of the release characterization program for AAOI-16 include:

- o determining if Constituents of Concern were released during steam cleaning activities; and
- o determining the nature, concentration, and extent of the Constituents of Concern released (if any).

In Phase IB, soil and ground water will be investigated from AAOI-16. Soil will be sampled from soil borings; ground water will be sampled from newly installed monitoring wells. Two sampling rounds will be performed for each Media of Concern.

In Round 1, soil from one boring (B-16A) will be advanced beneath AAOI-16 (see Figure 4-1). The exact location of the boring will be based on information provided by CIBA-GEIGY personnel to get it as close to the surface water catch basin as possible. In Round 2, two additional borings will be collected from AAOI-16. One sample, collected from the location sampled in Round 1, will verify the analytical results of the first sampling round. An additional boring, advanced further downslope of the catch basin, will be used to characterize further the extent of soil contamination, if any, within this area. Soil samples from both rounds will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

Two new monitoring wells will be installed downgradient of AAOI-16 to determine if ground water has been impacted by unsuspected past releases (see Figure 4-1). A shallow well (MW-17S) will be screened across the water table to evaluate the water quality of the upper aquifer and to determine if floating liquid

is present. A deep well (MW-17D) will be screened just above a confining layer (e.g., clay, till, bedrock) to evaluate the presence of DNAPLs. Ground water samples will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

Monitoring wells sampled in Round 1 will be resampled in Round 2. Round 2 ground water samples will be collected to verify the analytical results of the first sampling round and to evaluate the effect of seasonality on ground water. Round 2 ground water samples also will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters.

#### 4.1.17 Background Water Quality Study

Water quality in the on-site areas will be investigated in Phase 1B through both a release characterization (previously discussed) and a background study. The on-site release characterization was required by the Order. The background study proposed by CIBA-GEIGY is discussed here.

The strategy for evaluating on-site background water quality will be proposed in Phase 1B after the new monitoring wells have been installed, all wells (new and existing) have been sampled, and the analytical data have been compiled and evaluated. The proposed background investigation will address well placement, well construction, and the number of upgradient monitoring wells that will be installed.

Monitoring wells installed during the background investigation will be:

- located upgradient of past facility releases to provide representative samples of background water quality;

- installed and screened across the same stratigraphic interval as the downgradient monitoring wells to ensure comparability of data;
- sampled for the same analytes as the downgradient monitoring wells; and
- of sufficient number to account for heterogeneity in background water quality.

Details of the background water quality investigation will be proposed in future monthly report to USEPA for their review and comment.

## 4.2 OFF-SITE AREA

Surficial soils in the off-site area will be investigated in Phase IB through both a release characterization and a background study. A release characterization of selected off-site areas is required by the Order. The following discussion addresses the unit and waste history, previous analytical results, and the Release Characterization Strategy for the off-site area. The background study proposed by CIBA-GEIGY also is described.

### 4.2.1 Off-Site Area: Unit and Waste History

Surficial soils in the off-site area may have been impacted by past facility manufacturing operations. Air releases from a variety of different sources have been documented. Although the main process buildings (AOC-13) were equipped with scrubbers to control emissions, some stacks discharged directly to the atmosphere without controls. These direct discharges sometimes contained volatile organic compounds (including toluene and xylene). In the early 1980s, air discharges from the main plant boiler in Building 21 also were documented. During this period, CIBA-GEIGY burned by-product solvents (including recovered acetone, and toluene and heptane) as an alternate fuel.

Two uncontrolled air releases resulting from chemical manufacturing processes have been documented by CIBA-GEIGY. On 17 June 1980, Tinuvin 328 was released to the surrounding neighborhood. Tinuvin 328, a plastic stabilizer used in food packaging, is considered by CIBA-GEIGY to be non-toxic. The second release occurred on 24 June 1982, when approximately 25 gallons of Dowtherm A (a heat exchange oil) was released over a 15-minute period from the boiler expansion tank vent pipe line. The oil release, consisting of diphenyl ether and biphenyl, migrated southeasterly from Building 10 toward Warwick.

#### 4.2.2 Off-Site Area: Previous Analytical Results

Surficial soils in the off-site area were sampled by RIDEM on three different occasions to determine if the soil has been impacted by past CIBA-GEIGY operations. Soil samples from the neighborhood were collected on 23 July 1986, 12 November 1986, and 15 April 1987. The analytical results of these samples are summarized in Tables 6-14 and 6-16, Chapter 1 - Current Assessment Summary Report. Sampling locations are shown in Figure 6-2 in Chapter 1. Based on these results, RIDEM concluded that there is no widespread impact on soil in the off-site environment resulting from the facility's operating emissions and that any contamination present in the area surrounding the facility does not present a significant health threat.

Additional soil samples in the off-site environment were collected by the USEPA on 19 May 1988. Four samples (two at each field) were collected from Fay Field (located about 0.6 miles northeast of the Facility) and Park View Junior High School ball field (located 0.4 miles northwest of the Facility). Samples were analyzed for volatile and semi-volatile organic compounds, pesticides, and PCBs. The analytical results are on file with the USEPA and CIBA-GEIGY. A USEPA toxicologist calculated the total potential lifetime cancer risk level associated with the Constituents of Concern detected in these samples to be one in one million. A one in one million cancer risk is a risk defined as one additional potential cancer occurrence per one million persons continually exposed to the

Constituents of Concern during their lifetimes. In a letter dated 1 November 1988 to Representative Irving H. Levin regarding this matter, the USEPA stated the following:

"In EPA's opinion this represents an insignificant cancer risk probability of one in one million."

#### **4.2.3 Off-Site Area: Release Characterization Strategy**

The Release Characterization Strategy for the off-site area will determine if soils have been impacted by past facility releases. The objectives of the release characterization program for the off-site area include:

- o determining the nature, concentration, and extent of contamination that may have been released from the facility; and
- o verifying the analytical results and conclusions of the RIDEM and USEPA investigations.

Fourteen surficial soil samples will be collected in the off-site area in Phase IB (see Table 4-3). Eleven of these samples will be collected from the locations identified in the Order. Two nearby schools and one playground in Warwick, not required by the Order, also will be sampled by CIBA-GEIGY for completeness. All off-site surficial samples will be analyzed for target compounds (i.e., compounds detected on-site in Round 1 of sampling). Sampling in the off-site area will not begin until the analytical results from the first on-site sampling event (Round 1) have been compiled and evaluated.

#### **4.2.4 Off-Site Area: Background Study**

A background study will be conducted to compare the analytical results from data collected on-site with existing (background) concentrations of both naturally

occurring materials (e.g., metals) and of man-made chemicals, in the surrounding communities. The data will establish a regional frame of reference for the on-site concentrations of naturally occurring materials that are significantly above background, against which the quantities man-made chemicals observed on-site will be evaluated.

Surficial soil from background locations will be analyzed for Appendix IX compounds and fingerprint compounds in both sampling rounds (Table 4-4). In Round 1 one surficial sample (6 to 12 inches) will be collected from each location. In Round 2 an additional soil sample, taken at a location sampled in Round 1, will be used to verify the analytical results of the first sampling round. The four locations for the background study of the off-site area are summarized in Table 4-4. These locations were selected because they are:

- o located predominantly upwind from the site (based on the wind rose in Figure 4-1 of Chapter 1 - Current Assessment Summary Report and
- o located on readily accessible, publicly owned land within about three miles of the site.

### **4.3 PAWTUXET RIVER AREA**

#### **4.3.1 Pawtuxet River Area: Unit and Waste Area**

The Pawtuxet River has received discharges from many industries and several sewage treatment plants since the beginning of the industrial revolution. Prior to the industrial revolution and dating back to the 1700s, forges and textile mills discharged to the Pawtuxet River; privies serving up to 3000 employees were positioned directly over the river.

Originally, discharges from the facility to the Pawtuxet River occurred through the cofferdam/wastewater outfall associated with the Production Area.

That structure was used until the on-site waste water treatment plant began operation. As part of the operation of the waste water treatment plant, CIBA-GEIGY was permitted to discharge treated water to the Pawtuxet River via Outfall 001. The nature of the discharge is discussed in Section 4.1.12 (SWMU-12).

Other regular discharges to the Pawtuxet River included water from the cooling tower. That water discharged via Outfall 002. Cooling water sprayed onto drums stored in the Warwick Area discharged to the Pawtuxet River via Outfalls 003 and 004.

#### **4.3.2 Pawtuxet River Area: Previous Analytical Results**

The literature review conducted as part of the Current Assessment Summary Report (Chapter 1) indicates that water from the Pawtuxet River has not been sampled since May 1986 (when chemical manufacturing operations at the facility ceased). There are many water quality reports for the Pawtuxet River that pre-date the cessation of operations at the facility. Those reports characterize water quality primarily in terms of physical parameters, microbiological and inorganic constituents, and parameters such as COD, BOD and dissolved oxygen. Because of the dynamic nature of surface water, past sampling is not indicative of current conditions. The surface water investigation to be conducted as part of this Facility Investigation will address the impact, if any, that site conditions are having on surface water quality.

As part of the Facility Assessment, sediment quality was investigated. Four sediment samples collected from the Pawtuxet River near the site are shown in Figure 6-1 Chapter 1 - Current Assessment Summary Report. The samples were analyzed for metals, volatile and semi-volatile organic compounds, and pesticides/PCBs. Two of those samples also were analyzed for dioxin (TCDD) and furan (TCDF). The depth intervals for the samples are not reported. The analytical data for those samples are presented in Table 6-17 in Chapter 1. CIBA-GEIGY collected split sediment samples. The analytical data for those samples also are presented in Table 6-17.

The highest concentrations of arsenic (9.3 ppm), barium (222 ppm), chromium (1,080 ppm), iron (21,100 ppm), lead (369 ppm), magnesium (3,610 ppm), mercury (23 ppm), vanadium (943 ppm), zinc (2,280 ppm), toluene (0.23 ppm), tetrachloroethylene (1.7 ppm), 2-butanone (0.74 ppm), acetone (4.7 ppm), and polycyclic aromatic hydrocarbons (57.15 ppm) were detected in the upstream sediment sample. That sample was collected about 200 feet upstream of the western boundary of the Production Area.

The highest concentrations of antimony (4 ppm), beryllium (2.0 ppm), cadmium (16 ppm), manganese (560 ppm), nickel (33 ppm), silver (5.2 ppm), and phthalated esters (10.62 ppm) were detected in sediment samples collected adjacent to the facility. Most of the constituents detected were in the sediment sample collected adjacent to the Waste Water Treatment Area.

Chlorobenzene (0.13 ppm) and dieldrin (0.89 ppm) were detected in only one sediment sample. That sample was collected adjacent to the Warwick Area and upstream of the Waste Water Treatment Area. Dioxin (TCDD) and furan (TCDF) were not detected in the two sediment samples analyzed for those parameters.

Some compounds observed in sediment samples from the Pawtuxet River are attributable to past operations at the facility. However, many compounds may have been contributed from other sources. Regardless of their origin, Constituents of Concern occur in the sediment underlying the Pawtuxet River. Those conditions will be investigated during the Pawtuxet River area release characterization.

#### **4.3.3 Pawtuxet River Area: Release Characterization Strategy**

Releases to the Pawtuxet River associated with SWMUs-9, -10, and -12 were discussed (Section 4.1.) The Release Characterization Strategy for the Pawtuxet River area is based on the requirements of the Order, the current understanding of



the river conditions, and the data needs identified in the Preliminary Investigation of Corrective Measures (Section 2). The objectives of the Pawtuxet River release characterization are to:

- o evaluate the nature and extent of the releases;
- o evaluate the potential public health and environmental risks associated with surface water and sediment; and
- o develop and evaluate potential corrective measures, if appropriate, that will achieve the Media Protection Standards.

A minimum of nine surficial sediment samples will be collected from the bed of the Pawtuxet River. Two samples will be collected upstream of the Production Area: one sample upstream and one sample downstream of the Bellefont Pond outlet. One sample will be collected downstream of the facility reach to document dilution or attenuation of contaminants, if any. The remaining six samples will be collected at locations recommended in the Phase 1A report. All surficial sediment samples will be collected with a hand operated vertical pipe corer (i.e., hand corer). A one-foot core will be retrieved at each sampling location and analyzed for the Constituents of Concern listed in Table 4-5. The proposed bed sediment sampling locations are shown on Figure 4-3; the bed sediment sampling and analysis program is summarized in Table 4-5. Actual sampling locations may be slightly adjusted on the basis of river conditions at the time of sampling.

The bed sediment samples will be designated with "SD", followed by the transect number (established during the bathymetric survey), followed by either an "M", "L" or "R" (to indicate middle, left, or right, respectively, looking upstream). For example, a sample designated "SDF05L" indicates a sediment sample collected from the facility reach along transect F05 from the left side of the river.

Seven surface water samples will be collected from the Pawtuxet River along the facility reach at the locations shown on Figure 4-2. (The facility reach extends from the Bellefont Pond confluence to just downstream of the Warwick Avenue bridge.) Five of the surface water samples will be collected from locations adjacent to the facility (i.e., midstream samples). These five midstream samples will each be collected downstream of one of the five former outfalls. Each downstream location of an outfall will correspond to the next (i.e., nearest) downstream bathymetric transect location. The other two samples will be collected within the facility reach -- one sample will be collected upstream of the defined upstream facility boundary, and one sample will be collected downstream of the defined downstream facility boundary.

Dip samples will be collected at each of the five midstream surface water sampling locations. These samples will be analyzed (Table 4-5) for the Appendix IX and fingerprint compounds plus total dissolved solids, total suspended solids, biological and chemical oxygen demand, alkalinity, total organic carbon, major ions, and nutrients. Conductivity, pH, temperature, and dissolved oxygen will be measured in the field.

Dip samples also will be collected from the upstream and downstream sampling locations within the facility reach. These upstream and downstream surface water samples will be analyzed for only the Appendix IX and fingerprint compounds detected in the midstream samples (Table 4-5). Both filtered and unfiltered samples will be submitted from the upstream and downstream locations. The samples will be filtered in the field. Pressure filtering will be used if volatile organic compounds are included in the analytes to be tested. Only glass fiber filters will be used when filtering samples scheduled for analyses of organic compounds.

During Phase I, the midstream surface water samples will be collected once during low flow (i.e., base flow) conditions and once during high flow (i.e., storm

flow) conditions. If high flow conditions are not available during Phase I, then the surface water sampling and analysis program described here will continue into the Phase I-Phase II interim (and possibly into Phase II). Upstream and downstream surface water samples will be collected twice during base flow conditions.

Overall, the Release Characterization Strategy for the Pawtuxet River permits evaluating the potential public health and environmental risks associated with surface water and sediment. If necessary, it also permits developing and evaluating potential corrective measures that will achieve Media Protection Standards. Sediment samples will be collected from locations that are likely to indicate the nature and extent of past releases based on facility operation. These sampling locations correspond to the locations of the former outfalls and the former ORTF. Surface water samples will be collected downstream of each of the former outfall locations to assess the impact, if any, that potential resuspension of bed sediment in the vicinity of the former outfalls might be having on surface water quality. The surface water samples also will indicate if the quality of surface water within the facility reach changes as the result of ground water gain. The upstream and downstream surface water samples will provide information about the extent to which ground water quality affects surface water quality (if that effect is quantifiable). The Release Characterization Program for the Pawtuxet River Area has been designed to meet the requirements of the Order and the associated objectives (described earlier).

The next section -- the Source Characterization work plan -- describes the scope of work that will be performed for characterizing both the wastes (or hazardous constituents) and the units (SWMUs and AOCs) from which suspected releases may have occurred.

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FACILITY INVESTIGATION WORK PLAN  
SECTION 5  
SOURCE CHARACTERIZATION

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### 5.1 INTRODUCTION

This section presents the Source Characterization work plan. Source characterization entails both waste characterization and unit (e.g., SWMU and AOC) characterization. Waste characterization includes waste sampling, which may be of limited utility if the unit of concern is no longer active or if the types of waste managed in the unit varied over time. Unit characterization includes (1) the design and operational features of the unit that affect(ed) the rate of release, and (2) the location within the unit from which a release is occurring, has occurred, or may have occurred.

### 5.2 OBJECTIVES

According to the Order, the objectives of source characterization are to provide information that will facilitate:

- o the hazard classification of waste placed in each SWMU or AOC with regard to whether it is either a non-hazardous waste or a listed or characteristic hazardous waste, and (if it is a characteristic hazardous waste) what the characteristics are that render it hazardous;
- o the characterization of SWMUs and AOC with regard to location, type, design features, operating practices, period of operation, age, general physical condition, and the method used to close the SWMU or AOC; and

- o the characterization of wastes placed in the SWMU or AOC with regard to classification, quantity, chemical composition, and physicochemical properties (including toxicity, persistence, and migration and dispersal properties).

Because the SWMUs are no longer active and the types of waste managed at most of the SWMUs varied considerably over time, it is believed that some of the objectives of the Order are not completely applicable to the facility. As discussed in the Current Assessment Summary Report (Chapter 1), the facility has been decommissioned and production related facilities have been razed. As part of decommissioning and razing of the facility, most of the easily accessible materials, residues, and hazardous wastes have been removed from the facility.

Based on the status of the facility, it is believed that the following objectives are appropriate, achievable, and consistent with the requirements of the Order:

- o To render a hazard classification of environmental media (impacted by a release or releases) with regard to whether it is either a non-hazardous waste, or a listed or characteristic hazardous waste, and (if it is a characteristic hazardous waste) what the characteristics are that render it hazardous.
- o To characterize SWMUs and AOCs with regard to location, type, design features, operating practices, period of operation, age, general physical condition during operation, and the method used to close the SWMU or AOC.
- o To characterize wastes detected in Media of Concern with regard to physiochemical properties including quantity, toxicity, mobility, and persistence.

### 5.3 STRATEGY

To a limited extent, Source Characterization has been addressed in the Current Assessment Summary Report (Chapter 1). Based on that earlier description of SWMUs and AOCs and on the conceptual release model for each SWMU (described here), a proposal for waste characterization sampling and analysis is presented in the following discussion.

#### 5.3.1 Waste Characterization

Because most of the easily accessible materials, residues, and hazardous wastes have been removed from the facility, waste stream sampling is inappropriate for this investigation. Therefore, waste characterization will include sampling of Media of Concern potentially impacted by one or more releases.

In general, waste characterization sampling and analysis will be conducted as part of the Release Characterization (discussed in Section 4). That is, in order to determine if Media of Concern have been impacted by one or more releases of hazardous waste, the media will be sampled and analyzed for Appendix IX compounds and fingerprint compounds. The justification for analyzing for Appendix IX compounds and fingerprint compounds is presented in Section 4.1 (Sampling Parameters).

Based on the analytical results associated with the Release Characterization, further sampling and analyses will be conducted (1) if the Toxicity Characteristic Leaching Procedure (TCLP) concentrations are exceeded, or (2) if non-specific source, specific source, acute, or toxic hazardous waste constituents are detected at concentrations above treatment standards as outlined in 40 CFR Part 268. The need for additional waste characterization sampling and analyses will be evaluated in the Phase I Interim Report and addressed, if necessary, in the Phase II Proposal.

Specific waste characterization sampling and analyses will be conducted at SWMUs that were associated with ignitable, corrosive, or reactive wastes. SWMUs-1 and -2 stored ignitable and corrosive wastes. Reactive wastes were not associated with facility operations. The Order does not require sampling at SWMU-1. As a conservative approach, soil potentially impacted by one or more releases from each of the SWMUs will be sampled and analyzed for characteristics of ignitability and corrosivity. The locations of the soil samples are based on the conceptual release models for SWMUs-1 and -2 described above.

It is believed that describing the physiochemical waste characterization of each Constituent of Concern placed in each SWMU and AOC is inappropriate. It may be more appropriate to describe the physiochemical waste characteristics of the Constituents of Concern detected in environmental media. Probably, it is most appropriate to describe a subset of the detected Constituents of Concern (e.g., indicator chemicals). The decision about which group of Constituents of Concern is to be described in the RFI Report will be made by the USEPA (after being informed of the results of the Source Characterization). At this time, CIBA-GEIGY believes that describing the indicator chemicals will be most appropriate. If indicator chemicals are described, then that description will be presented in the PHERE section of the RFI Report.

### 5.3.2 Unit Characterization

Unit characterization will include a description of the physical characteristics of each SWMU and AOC, and (if appropriate) the method used to close the SWMU. Physical characteristics include:

- o the location and type of SWMU or AOC;
- o the design features;
- o the operating practices; and
- o the period of operation.

The information source(s) for these characteristics also will be reported.

Waste characterization and unit characterization will be conducted during Phase I and II of the RCRA Facility Investigation, and will be documented in the RFI Report.

This section presented the Source Characterization work plan, which describes the scope of work that will be performed for characterizing the wastes (or hazardous constituents) and the units (SWMUs and AOCs) from which suspected releases may have occurred. The work plans for characterizing the physical site (Section 3), and the sources of releases (this section) permit developing a Preliminary Phase II Proposal (described in the next section).



**VOLUME 1 - CHAPTER 3**  
**FACILITY INVESTIGATION WORK PLAN**  
**SECTION 6**  
**PRELIMINARY PHASE II PROPOSAL**

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This section presents a preliminary proposal for the scope of work in Phase II of the Facility Investigation. Phase II is the second of four phases of the RFI being conducted pursuant to the Order. Because the scope of the Phase II investigation depends on the results of the Phase I study, only a preliminary Phase II proposal can be presented at this time; the final Phase II proposal will be submitted to the USEPA with the Phase I Interim Report (shortly after the conclusion of the Phase I investigation). Phase II will begin after receiving written approval from the USEPA.

In Phase II, three main tasks will be performed to provide the information needed both for the final RFI Report and to develop the Media Protection Standards Proposal:

- o additional site characterization tasks;
- o additional release characterization studies; and
- o identification of new Conditions of Concern, if appropriate.

These Phase II tasks are described here.

#### **6.1 ADDITIONAL SITE CHARACTERIZATION TASKS**

A comprehensive understanding of the facility's physical environment is required before the total impact of any release from the facility can be evaluated. A comprehensive Physical Site Characterization Study will have been performed in Phase IA, but additional studies may be required in Phase II if data gaps are identified during the analysis of Phase IA information. Phase II

characterization studies may include additional geophysical surveys, geologic studies, hydrogeologic studies, or hydrologic investigations.

#### **6.1.1 Additional Geophysical Investigations**

Additional geophysical investigations may be needed as a follow-on to Phase I. These needs will be identified after data from the Physical Site Characterization Study (Phase IA) and the Release Characterization Study (Phase IB) have been analyzed and interpreted. Depending on the results of the Phase IA geophysical investigations, field measurements using the same or new techniques, and/or using different methods of data reduction and interpretation, may be proposed for Phase II.

#### **6.1.2 Additional Geologic Investigations**

A comprehensive geologic investigation will be performed in Phase I, but additional investigations may be needed to understand the local geologic environment. Additional Phase II geologic investigations may include stratigraphic borings and laboratory testing of soil samples, rock coring, and geologic mapping studies.

#### **6.1.3 Additional Hydrogeologic Investigations**

In Phase I, monitoring wells and piezometers will be installed throughout the facility to complement the existing monitoring network. On a quarterly basis, ground water flow rates at monitoring wells and piezometers will be tested and water levels will be monitored. However, conditions may be encountered in Phase I which require conducting additional hydrogeologic investigations. For example, in areas where ground water conditions are poorly understood, new monitoring wells and piezometers will be installed and tested. Additional hydrogeologic investigations will be performed in areas exhibiting ground water mounding, perched water tables, or anomalous water level data. Monitoring of water levels

will continue in Phase II until preparation of the RFI Report begins.

#### **6.1.4 Additional Hydrologic Investigations**

Hydrologic investigations of the Pawtuxet River will be performed in Phase IA to identify representative sampling locations for the Release Characterization Study (Phase IB). Additional hydrologic investigations of the river may be performed in Phase II if certain conditions (e.g., high or low discharge events) are not encountered in Phase I. Monitoring of water levels will continue until preparation of the RFI Report begins. Additional sampling of surface water and sediment further downstream may be needed. The details of any Phase II hydrologic investigations will be proposed after the results from Phase I have been evaluated.

### **6.2 ADDITIONAL RELEASE CHARACTERIZATION STUDIES**

Release characterization studies will be performed in Phase I to identify the nature and extent of contaminants released from the facility. In Phase II, additional release characterization studies will be performed to provide data required both for the RFI Report and for developing the proposed Media Protection Standards. Phase II release characterization studies will consist of additional sampling and analysis of designated media in both the on-site and off-site environments.

#### **6.2.1 On-Site Studies**

Sampling of the three on-site areas will continue in Phase II. All Media of Concern identified in the Order will be sampled and analyzed at least twice. Additional monitoring wells may be installed to delineate the extent of ground water contamination resulting from past releases. Media of Concern sampled in Phase II may be analyzed for indicator compounds, geotechnical parameters, or additional treatability analytes. The specifics of the on-site Phase II release

characterization studies will be proposed after evaluating the results obtained in Phase I.

#### **6.2.2 Off-Site (Neighborhood) Studies**

Sampling and analysis of required Media of Concern off-site will continue in Phase II. In the neighborhoods surrounding the facility, additional soil samples (and other Media of Concern, if deemed necessary by the USEPA) will be analyzed. Phase II samples will be used to verify the results from Phase I. Sampling of new locations may be required to characterize the extent and impact of past facility air releases. Additionally, samples also may be collected in Phase II to evaluate the environmental background more completely. The sampling strategy for the adjacent neighborhoods will be presented after Phase I results have been evaluated.

#### **6.2.3 Off-Site (River) Studies**

In Phase II, additional off-site sampling and analysis of Media of Concern in the river and other surface water bodies will be performed, if appropriate. The Phase II river studies will focus on determining the extent of contamination resulting from past facility discharges. Additional sampling of surface water and sediment is anticipated. The Phase II sampling strategy will be proposed after evaluating the results obtained in Phase I.

### **6.3 IDENTIFICATION OF NEW CONDITIONS OF CONCERN**

New Conditions of Concern, if encountered after submitting the RFI Proposal, will be identified in the Phase II proposal. New Conditions of Concern may include additional Media of Concern for SWMUs and AOCs listed in the Order, or entirely new SWMUs or AOCs, or a determination that releases identified in the Order warrant immediate attention.

### **6.3.1 Additional Media of Concern**

After submitting the RFI Proposal, additional Media of Concern may be identified for the SWMUs or AOCs listed in the Order. If so, the Order's appropriate attachments will be modified and submitted as part of the Phase II proposal. The proposal also will indicate that new Media of Concern will be investigated, and will include a schedule showing how the proposed media characterization studies will be integrated into the ongoing investigation.

### **6.3.2 New SWMUs or AOCs**

Entirely new SWMUs or AOCs may be identified after submitting the RFI Proposal. If so, these new SWMUs and AOCs, and the Media of Concern pertinent to them, will be identified; the Order's appropriate attachments will be modified and submitted as part of the Phase II proposal. The proposal also will indicate that new SWMUs or AOCs will be investigated, and will include a schedule showing how the proposed characterization studies will be integrated into the ongoing investigation.

### **6.3.3 Conditions Warranting Immediate Attention**

Releases from SWMUs, AOCs, or Media of Concern listed in the Order may be found to warrant immediate attention. If so, interim measures will be proposed along with appropriate supporting schedules and protocols. An interim measures report will be submitted to the USEPA four weeks after the last interim measures task has been completed.

## **6.4 SCHEDULE AND DELIVERABLES**

The Phase II investigation will be completed within the time frames specified in the Order. Eleven months are permitted to complete Phase II -eight months for the field investigation and three months to prepare, review, and produce the RFI Report and Media Protection Standards proposal. These time frames will not be exceeded without written approval from the USEPA project manager.

This section presented a preliminary proposal for Phase II of the Facility Investigation. The proposal includes additional tasks regarding site characterization, release characterization, and identification of new Conditions of Concern (if appropriate). These additional tasks will provide the data needed both for the Final RFI Report and to develop Media Protection Standards. The next chapter presents the Quality Assurance Documents.

## **Tables**

TABLE 2-1  
CANDIDATE CORRECTIVE MEASURES AND TECHNOLOGY TYPES -  
GROUND WATER

OBJECTIVES:

For Human Health: Prevent ingestion of water having constituents of concern

For Environmental Protection: Restore aquifer to comply with applicable, or relevant standards and non-promulgated criteria.

Response Actions	Technology Types	Process Options
<p>No Action/Institutional Actions:</p> <p>No action</p> <p>Alternative residential water supply</p> <p>Monitoring</p>	<p>No Action/Institutional Options:</p> <p>Fencing</p> <p>Deed restrictions</p>	
<p>Containment Actions:</p> <p>Containment</p>	<p>Containment Technologies:</p> <p>Capping</p> <p>Vertical barriers</p> <p>Horizontal barriers</p>	<p>Clay cap, synthetic membrane, layer</p> <p>Slurry wall, sheet piling</p> <p>Liners, grout injection.</p>
<p>Collection/Treatment Actions:</p> <p>Collection/treatment discharge/ in-situ ground water treatment</p>	<p>Extraction Technologies:</p> <p>Ground water collection/pumping</p> <p>Enhanced removal</p> <p>Treatment Technologies:</p> <p>Physical treatment</p> <p>Chemical treatment</p> <p>In-situ treatment</p> <p>Disposal Technologies:</p> <p>Discharge to POTW or to surface water (after treatment)</p> <p>Reinjection</p>	<p>Wells, subsurface or leachate collection</p> <p>Coagulation/flocculation, air stripping, steam stripping, adsorption.</p> <p>Neutralization, precipitation, ion exchange oxidation/reduction</p> <p>Subsurface bioreclamation</p> <p>Either up or downgradient using injection wells or trenches</p>



TABLE 2-2  
CANDIDATE CORRECTIVE MEASURES AND TECHNOLOGY TYPES -  
SOIL

OBJECTIVES:

For Human Health: Prevent exposure/ingestion/direct contact/inhalation of soil having constituents of concern.

For Environmental Protection: Prevent migration of constituents of concern in soil.

Response Actions	Technology Types	Process Options
<p>No Action/Institutional Actions:</p> <p>No action</p> <p>Access restrictions</p> <p>Containment Actions:</p> <p>Containment</p> <p>Excavation/Treatment Actions:</p> <p>Excavation/Treatment/Disposal</p> <p>In-situ treatment</p> <p>Disposal excavation</p>	<p>No Action/Institutional Options:</p> <p>Fencing</p> <p>Deed restrictions</p> <p>Containment Technologies:</p> <p>Capping</p> <p>Vertical barriers</p> <p>Horizontal barriers</p> <p>Surface controls</p> <p>Sediment control barriers</p> <p>Dust controls</p> <p>Removal Technologies:</p> <p>Excavation</p> <p>Treatment Technologies:</p> <p>Solidification, fixation, stabilization, immobilization</p> <p>Dewatering</p> <p>Physical treatment</p> <p>Chemical treatment</p> <p>Biological treatment</p> <p>In-situ treatment</p> <p>Thermal treatment</p>	<p>Clay cap, synthetic membrane, multi-layer Slurry wall, sheet piling</p> <p>Liners, grout injection</p> <p>Diversion/collection, grading, soil stabilization</p> <p>Coffer dams, curtain barriers</p> <p>Revegetation, capping</p> <p>Solids excavation</p> <p>Sorption, pozzolanic agents, encapsulation</p> <p>Belt filter press, dewatering, and drying beds</p> <p>Water/solvent leaching (with subsequent liquids treatment)</p> <p>Lime neutralization</p> <p>Cultured microorganisms</p> <p>Surface bioreclamation</p> <p>Incineration, pyrolysis</p>

TABLE 2-2 (continued)  
CANDIDATE CORRECTIVE MEASURES AND TECHNOLOGY TYPES -  
SOIL

OBJECTIVES:

For Human Health: Prevent exposure/ingestion/direct contact/inhalation of soil having constituents of concern.

For Environmental Protection: Prevent migration of constituents of concern in soil.

Response Actions	Technology Types	Process Options
Treatment Actions	<p>Treatment:</p> <p>Vitrification</p> <p>Chemical Extraction</p> <p>Soil Washing</p> <p>In-Situ Soil Flushing</p> <p>Steam Extraction</p> <p>In-Situ Chemical Fixation</p>	<p>Treatment</p> <p>High temperature in soil created by electrodes, pyrolyzes organics and solidifies metals</p> <p>Soil excavation and solvent extraction</p> <p>Soil excavation and wash with water and surfactants</p> <p>In-place washing with solvent and recovery via wells for treatment</p> <p>Steam stripping soil for volatile removal</p> <p>Chemically fix metals by inplace auger</p>

TABLE 2-3  
CANDIDATE CORRECTIVE MEASURES AND TECHNOLOGY TYPES -  
SURFACE WATER

OBJECTIVES:

For Human Health: Prevent ingestion of water having constituents of concern

For Environmental Protection: Restore surface water to comply with applicable, or relevant and appropriate standards and non-promulgated criteria.

Response Actions	Technology Types	Process Options
<p>No Action/Institutional Actions:</p> <ul style="list-style-type: none"> <li>No action</li> <li>Access restrictions</li> <li>Monitoring</li> </ul>	<p>No Action/Institutional Options:</p> <ul style="list-style-type: none"> <li>Fencing</li> <li>Deed restrictions</li> </ul>	
<p>Collection/Treatment Actions:</p> <ul style="list-style-type: none"> <li>Surface water runoff interception/treatment/discharge</li> </ul>	<p>Collection Technologies:</p> <ul style="list-style-type: none"> <li>Surface controls</li> </ul> <p>Treatment Technologies:</p> <ul style="list-style-type: none"> <li>Physical treatment</li> <li>Chemical treatment</li> <li>Biological treatment (organics)</li> <li>In-situ treatment</li> </ul> <p>Disposal Technologies:</p> <ul style="list-style-type: none"> <li>Discharge to POTW (after treatment).</li> </ul>	<ul style="list-style-type: none"> <li>Grading, diversion, and collection</li> <li>Coagulation/flocculation, oil-water separation, filtration, adsorption</li> <li>Precipitation, ion exchange, neutralization, freeze crystallization biological treatment</li> <li>Aerobic and anaerobic spray irrigation</li> <li>In-situ precipitation, in-situ bio-reclamation</li> </ul>

TABLE 2-4  
CANDIDATE CORRECTIVE MEASURES AND TECHNOLOGY TYPES -  
SEDIMENT

OBJECTIVES:

For Human Health: Prevent exposure (ingestion/direct contact/inhalation) of sediment having constituents of concern.  
For Environmental Protection: Prevent releases of constituents of concern from sediments that would result in surface water levels to exceed applicable, or relevant and appropriate, promulgated standards and non-promulgated criteria.

Response Actions	Technology Types	Process Options
<p>No Action/Institutional Actions:</p> <p>No action</p> <p>Access restrictions</p> <p>Monitoring</p>	<p>No Action/Institutional Options:</p> <p>Fencing</p> <p>Deed restrictions</p>	
<p>Excavation Actions:</p> <p>Excavation</p>	<p>Removal Technologies:</p> <p>Excavation</p> <p>Containment Technologies:</p> <p>Capping</p> <p>Vertical barriers</p> <p>Horizontal barriers</p> <p>Sediment control barriers</p>	<p>Sediment excavation</p> <p>Removal with clay cap, multi-layer, asphalt</p> <p>Slurry wall, sheet piling</p> <p>Liners, grout injection</p> <p>Coffer dams, curtain barriers, capping barriers</p>
<p>Excavation/Treatment Actions:</p> <p>Removal/disposal</p> <p>Removal/treatment/disposal</p>	<p>Treatment Technologies:</p> <p>Solidification, fixation, stabilization</p> <p>Dewatering</p> <p>Physical treatment</p> <p>Chemical treatment</p> <p>Biological treatment</p> <p>In-situ treatment</p> <p>Thermal treatment</p>	<p>Sorption, pozzolanic agents, encapsulation</p> <p>Sedimentation, dewatering and drying beds</p> <p>Water/solids leaching (with subsequent treatment)</p> <p>Neutralization, oxidation, electrochemical reduction</p> <p>Landfarming</p> <p>Surface bioreclamation</p> <p>Incineration, pyrolysis</p>

**TABLE 2-5**  
**APPENDIX IX PARAMETERS**

Common name <sup>2</sup>	CAS RN <sup>3</sup>	Chemical abstracts service index name <sup>4</sup>	Sug- gested methods <sup>5</sup>	PQL (µg/L) <sup>6</sup>
Benzo[a]anthracene; Benzantracene	56-55-3	Benz[a]anthracene	8100 8270	200 10
Benzo[b]fluoranthene	205-99-2	Benz[e]acephenanthrylene	8100 8270	200 10
Benzo[k]fluoranthene	207-08-9	Benzo[k]fluoranthene	8100 8270	200 10
Benzo[ghi]perylene	191-24-2	Benzo[ghi]perylene	8100 8270	200 10
Benzo[a]pyrene	50-32-8	Benzo[a]pyrene	8100 8270	200 10
Benzyl alcohol	100-51-6	Benzenemethanol	8270	20
Beryllium	(Total)	Beryllium	6010 7090 7091	3 50 2
alpha-BHC	319-84-6	Cyclohexane, 1,2,3,4,5,6-hexachloro- (1α,2α,3β,4α,5β,6β)-	8080 8250	0.05 10
beta-BHC	319-85-7	Cyclohexane, 1,2,3,4,5,6-hexachloro- (1α,2β,3α,4β,5α,6β)-	8080 8250	0.05 40
delta-BHC	319-86-8	Cyclohexane, 1,2,3,4,5,6-hexachloro- (1α,2α,3α,4β,5α,6β)-	8080 8250	0.1 30
gamma-BHC; Lindane	58-89-9	Cyclohexane, 1,2,3,4,5,6-hexachloro- (1α,2α,3β,4α,5α,6β)-	8080 8250	0.05 10
Bis(2-chloroethoxy)methane	111-91-1	Ethane, 1,1'-[methylenebis(oxy)]bis[2-chloro-	8270	10
Bis(2-chloroethyl) ether	111-44-4	Ethane, 1,1'-oxybis[2-chloro-	8270	10
Bis(2-chloro-1-methylethyl)ether; 2,2'- Dichlorodiisopropyl ether	108-60-1	Propane, 2,2'-oxybis[1-chloro-	8010 8270	100 10
Bis(2-ethylhexyl) phthalate	117-81-7	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl)ester	8060 8270	20 10
Bromodichloromethane	75-27-4	Methane, bromodichloro-	8010 8240	1 5
Bromoform; Tribromomethane	75-25-2	Methane, tribromo-	8010 8240	2 5
4-Bromophenyl phenyl ether	101-55-3	Benzene, 1-bromo-4-phenoxy-	8270	10
Butyl benzyl phthalate; Benzyl butyl phthalate	85-68-7	1,2-Benzenedicarboxylic acid, butyl phenylmethyl ester	8060 8270	5 10
Cadmium	(Total)	Cadmium	6010 7130 7131	40 50 1
Carbon disulfide	75-15-0	Carbon disulfide	8240	5
Carbon tetrachloride	56-23-5	Methane, tetrachloro-	8010 8240	1 5
Chlordane	57-74-9	4,7-Methano-1H-indene, 1,2,4,5,6,7,8,8-octachloro- 2,3,3a,4,7,7a-hexahydro	8080 8250	0.1 10
p-Chloroaniline	106-47-8	Benzenamine, 4-chloro-	8270	20
Chlorobenzene	108-90-7	Benzene, chloro-	8010 8020 8240	2 2 5
Chlorobenzilate	510-15-6	Benzenesacetic acid, 4-chloro-α-(4-chlorophenyl)-α- hydroxyethyl ester	8270	10
p-Chloro-m-cresol	59-50-7	Phenol, 4-chloro-3-methyl-	8040 8270	5 20
Chloroethane; Ethyl chloride	75-00-3	Ethane, chloro-	8010 8240	5 10
Chloroform	67-66-3	Methane, trichloro-	8010 8240	0.5 5
2-Chloronaphthalene	91-58-7	Napthalene, 2-chloro-	8120 8270	10 10
2-Chlorophenol	95-57-8	Phenol, 2-chloro-	8040 8270	5 10
4-Chlorophenyl phenyl ether	7005-72-3	Benzene, 1-chloro-4-phenoxy	8270	10
Chloroprene	126-99-8	1,3-Butadiene, 2-chloro-	8010 8240	50 5

**TABLE 2-5**  
**APPENDIX IX PARAMETERS (CONTINUED)**

Common name <sup>2</sup>	CAS RN <sup>3</sup>	Chemical abstracts service index name <sup>4</sup>	Sug- gested methods <sup>5</sup>	PQL (µg/L) <sup>6</sup>
Chromium	(Total)	Chromium	6010 7180 7191	70 500 10
Chrysene	218-01-9	Chrysene	8100 8270	200 10
Cobalt	(Total)	Cobalt	6010 7200 7201	70 500 10
Copper	(Total)	Copper	6010 7210	60 200
m-Cresol	108-39-4	Phenol, 3-methyl-	8270	10
o-Cresol	95-48-7	Phenol, 2-methyl-	8270	10
p-Cresol	106-44-5	Phenol, 4-methyl-	8270	10
Cyanide	57-12-5	Cyanide	9010	40
2,4-D; 2,4-Dichlorophenoxyacetic acid	94-75-7	Acetic acid, (2,4-dichlorophenoxy)-	8150	10
4,4'-DDD	72-54-8	Benzene, 1,1'-(2,2-dichloroethylidene)bis[4-chloro-	8080 8270	0.1 10
4,4'-DDE	72-55-9	Benzene, 1,1'-(dichloroethylidene)bis[4-chloro-	8080 8270	0.05 10
4,4'-DDT	50-29-3	Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[4-chloro-	8080 8270	0.1 10
Diallate	2303-16-4	Carbamothioic acid, bis(1-methylethyl)-, S-(2,3-dichloro-2-propenyl) ester	8270	10
Dibenz[a,h]anthracene	53-70-3	Dibenz[a,h]anthracene	8100 8270	200 10
Dibenzofuran	132-64-9	Dibenzofuran	8270	10
Dibromochloromethane;	124-48-1	Methane, dibromochloro-	8010	1
Chlorodibromomethane			8240	5
1,2-Dibromo-3-chloropropane; DBCP	96-12-8	Propane, 1,2-dibromo-3-chloro-	8010 8240 8270	100 5 10
1,2-Dibromoethane;	106-93-4	Ethane, 1,2-dibromo-	8010 8240	10 5
Ethylene dibromide				
Di-n-butyl phthalate	84-74-2	1,2-Benzenedicarboxylic acid, dibutyl ester	8060 8270	5 10
o-Dichlorobenzene	95-50-1	Benzene, 1,2-dichloro-	8010 8020 8120 8270	2 5 10 10
m-Dichlorobenzene	541-73-1	Benzene, 1,3-dichloro-	8010 8020 8120 8270	5 5 10 10
p-Dichlorobenzene	106-46-7	Benzene, 1,4-dichloro-	8010 8020 8120 8270	2 5 15 10
3,3'-Dichlorobenzidine	91-94-1	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dichloro-	8270	20
trans-1,4-Dichloro-2-butene	110-57-6	2-Butene, 1,4-dichloro-, (E)-	8240	5
Dichlorodifluoromethane	75-71-8	Methane, dichlorodifluoro-	8010 8240	10 5
1,1-Dichloroethane	75-34-3	Ethane, 1,1-dichloro-	8010 8240	1 5
1,2-Dichloroethane; Ethylene dichloride	107-06-2	Ethane, 1,2-dichloro-	8010 8240	0.5 5
1,1-Dichloroethylene; Vinylidene chloride	75-35-4	Ethene, 1,1-dichloro-	8010 8240	1 5
trans-1,2-Dichloroethylene	156-60-5	Ethene, 1,2-dichloro-, (E)-	8010 8240	1 5
2,4-Dichlorophenol	120-83-2	Phenol, 2,4-dichloro-	8040 8270	5 10
2,6-Dichlorophenol	87-65-0	Phenol, 2,6-dichloro-	8270	10

**TABLE 2-5**  
**APPENDIX IX PARAMETERS (CONTINUED)**

Common name <sup>2</sup>	CAS RN <sup>3</sup>	Chemical abstracts service index name <sup>4</sup>	Sug- gested methods <sup>5</sup>	PQL (µg/L) <sup>6</sup>
1,2-Dichloropropane	78-87-5	Propane, 1,2-dichloro-	8010 8240	0.5 5
cis-1,3-Dichloropropene	10061-01-5	1-Propene, 1,3-dichloro-, (Z)-	8010 8240	20 5
trans-1,3-Dichloropropene	10061-02-6	1-Propene, 1,3-dichloro-, (E)-	8010 8240	5 5
Dieldrin	60-57-1	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1α,2β,2α,3β,6β,6α,7β,7α)-	8080 8270	0.05 10
Diethyl phthalate	84-66-2	1,2-Benzenedicarboxylic acid, diethyl ester	8060 8270	5 10
O,O-Diethyl O-2-pyrazinyl phosphorothioate; Thionazin Dimethoate	297-97-2	Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester	8270	10
p-(Dimethylamino)azobenzene	60-51-5	Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester	8270	10
7,12-Dimethylbenz[a]anthracene	60-11-7	Benzenamine, N,N-dimethyl-4-(phenylazo)-	8270	10
3,3'-Dimethylbenzidine	57-97-6	Benz[a]anthracene, 7,12-dimethyl-	8270	10
alpha, alpha-Dimethylphenethylamine	119-93-7	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethyl-	8270	10
2,4-Dimethylphenol	122-09-8	Benzenethanamine, α,α-dimethyl-	8270	10
Dimethyl phthalate	105-67-9	Phenol, 2,4-dimethyl-	8040 8270	5 10
m-Dinitrobenzene	131-11-3	1,2-Benzenedicarboxylic acid, dimethyl ester	8060 8270	5 10
4,6-Dinitro-o-cresol	99-65-0	Benzene, 1,3-dinitro-	8270	10
2,4-Dinitrophenol	534-52-1	Phenol, 2-methyl-4,6-dinitro-	8040 8270	150 50
2,4-Dinitrotoluene	51-28-5	Phenol, 2,4-dinitro-	8040 8270	150 50
2,6-Dinitrotoluene	121-14-2	Benzene, 1-methyl-2,4-dinitro-	8090 8270	0.2 10
Dinoseb; DNBP; 2-sec-Butyl-4,6-dinitrophenol	606-20-2	Benzene, 2-methyl-1,3-dinitro-	8090 8270	0.1 10
Di-n-octyl phthalate	88-85-7	Phenol, 2-(1-methylpropyl)-4,6-dinitro-	8150 8270	1 10
1,4-Dioxane	117-84-0	1,2-Benzenedicarboxylic acid, dioctyl ester	8060 8270	30 10
Diphenylamine	123-91-1	1,4-Dioxane	8015	150
Disulfoton	122-39-4	Benzenamine, N-phenyl-	8270	10
Endosulfan I	298-04-4	Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester	8140 8270	2 10
Endosulfan II	959-98-8	6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide, (3α,5αβ,6α,9α,9aβ)-	8080 8250	0.1 10
Endosulfan sulfate	33213-65-9	6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide, (3α,5αα,6β,9β,9aα)-	8080	0.05
Endrin	1031-07-8	6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3,3-dioxide	8080 8270	0.5 10
Endrin aldehyde	72-20-8	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1α,2β,2αβ,3α,6α,6aβ,7β,7aα)-	8080 8250	0.1 10
Ethylbenzene	7421-93-4	1,2,4-Methenocyclopental[cd]pentalene-5-carboxaldehyde, 2,2a,3,3,4,7-hexachlorodecahydro-, (1α,2β,2aβ,4β,4aβ,5β,6aβ,6bβ,7R <sup>5</sup> )-	8080 8270	0.2 10
Ethyl methacrylate	100-41-4	Benzene, ethyl-	8020 8240	2 5
Ethyl methanesulfonate	97-63-2	2-Propenoic acid, 2-methyl-, ethyl ester	8015 8240 8270	10 5 10
Famphur	62-50-0	Methanesulfonic acid, ethyl ester	8270	10
	52-85-7	Phosphorothioic acid, O-[4-[(dimethylamino)sulfonyl]phenyl]-O,O-dimethyl ester	8270	10

**TABLE 2-5**  
**APPENDIX IX PARAMETERS (CONTINUED)**

Common name <sup>2</sup>	CAS RN <sup>3</sup>	Chemical abstracts service index name <sup>4</sup>	Sug- gested methods <sup>5</sup>	PQL (µg/L) <sup>6</sup>
Fluoranthene	206-44-0	Fluoranthene	8100 8270	200 10
Fluorene	86-73-7	9H-Fluorene	8100 8270	200 10
Heptachlor	76-44-8	4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro- 3a,4,7,7a-tetrahydro-	8080 8270	0.05 10
Heptachlor epoxide	1024-57-3	2,5-Methano-2H-indeno[1,2b]oxirene, 2,3,4,5,6,7,7-hep- tachloro-1a,1b,5,5a,6,6a-hexahydro-, (1aα,1bβ,2α,5α,5aβ,6β,6aα)	8080 8270	1 10
Hexachlorobenzene	118-74-1	Benzene, hexachloro-	8120 8270	0.5 10
Hexachlorobutadiene	87-68-3	1,3-Butadiene, 1,1,2,3,4,4-hexachloro-	8120 8270	5 10
Hexachlorocyclopentadiene	77-47-4	1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-	8120 8270	5 10
Hexachloroethane	67-72-1	Ethane, hexachloro-	8120 8270	0.5 10
Hexachlorophene	70-30-4	Phenol, 2,2'-methylenebis[3,4,6-trichloro-	8270	10
Hexachloropropene	1888-71-7	1-Propene, 1,1,2,3,3,3-hexachloro-	8270	10
2-Hexanone	591-78-6	2-Hexanone	8240	50
Indeno[1,2,3-cd]pyrene	193-39-5	Indeno[1,2,3-cd]pyrene	8100 8270	200 10
Isobutyl alcohol	78-83-1	1-Propanol, 2-methyl-	8015	50
Isodrin	465-73-6	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro- 1,4,4a,5,8,8a-hexahydro-(1α,4α,4aβ,5β,8β,8aβ)-	8270	10
Isophorone	78-59-1	2-Cyclohexen-1-one, 3,5,5-trimethyl	8090 8270	60 10
Isosafrole	120-58-1	1,3-Benzodioxole, 5-(1-propenyl)-	8270	10
Kepone	143-50-0	1,3,4-Metheno-2H-cyclobuta[cd]pentalen-2-one, 1,1a,3,3a,4,5,5,5a,5b,6-decachlorooctahydro-	8270	10
Lead	(Total)	Lead	6010 7420 7421	40 1,000 10
Mercury	(Total)	Mercury	7470	2
Methacrylonitrile	126-98-7	2-Propanenitrile, 2-methyl-	8015 8240	5 5
Methapyrilene	91-80-5	1,2-Ethanediamine, N,N-dimethyl-N'-2-pyridinyl-N'-(2- thienylmethyl)-	8270	10
Methoxychlor	72-43-5	Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[4-methoxy-	8080 8270	2 10
Methyl bromide; Bromomethane	74-83-9	Methane, bromo-	8010 8240	20 10
Methyl chloride; Chloromethane	74-87-3	Methane, chloro-	8010 8240	1 10
3-Methylcholanthrene	56-49-5	Benz[j]aceanthrylene, 1,2-dihydro-3-methyl-	8270	10
Methylene bromide; Dibromomethane	74-95-3	Methane, dibromo-	8010 8240	15 5
Methylene chloride; Dichloromethane	75-09-2	Methane, dichloro-	8010 8240	5 5
Methyl ethyl ketone; MEK	78-93-3	2-Butanone	8015 8240	10 100
Methyl iodide; Iodomethane	74-88-4	Methane, iodo-	8010 8240	40 5
Methyl methacrylate	80-62-6	2-Propenoic acid, 2-methyl-, methyl ester	8015 8240	2 5
Methyl methanesulfonate	66-27-3	Methanesulfonic acid, methyl ester	8270	10
2-Methylnaphthalene	91-57-6	Naphthalene, 2-methyl-	8270	10
Methyl parathion; Parathion methyl	298-00-0	Phosphorothioic acid, O,O-dimethyl O-(4-nitrophenyl) ester	8140 8270	0.5 10



**TABLE 2-5**  
**APPENDIX IX PARAMETERS (CONTINUED)**

Common name <sup>2</sup>	CAS RN <sup>3</sup>	Chemical abstracts service index name <sup>4</sup>	Sug- gested methods <sup>5</sup>	PQL (µg/L) <sup>6</sup>
4-Methyl-2-pentanone; Methyl isobutyl ketone	108-10-1	2-Pentanone, 4-methyl-	8015 8240	5 50
Naphthalene	91-20-3	Naphthalene	8100	200
1,4-Naphthoquinone	130-15-4	1,4-Naphthalenedione	8270	10
1-Naphthylamine	134-32-7	1-Naphthalenamine	8270	10
2-Naphthylamine	91-59-8	2-Naphthalenamine	8270	10
Nickel	(Total)	Nickel	6010 7520	50 400
o-Nitroaniline	88-74-4	Benzenamine, 2-nitro-	8270	50
m-Nitroaniline	99-09-2	Benzenamine, 3-nitro-	8270	50
p-Nitroaniline	100-01-6	Benzenamine, 4-nitro-	8270	50
Nitrobenzene	98-95-3	Benzene, nitro-	8090 8270	40 10
o-Nitrophenol	88-75-5	Phenol, 2-nitro	8040 8270	5 10
p-Nitrophenol	100-02-7	Phenol, 4-nitro-	8040 8270	10 50
4-Nitroquinoline-1-oxide	56-57-5	Quinoline, 4-nitro-, 1-oxide	8270	10
N-Nitrosodi-n-butylamine	924-16-3	1-Butanamine, N-butyl-N-nitroso-	8270	10
N-Nitrosodiethylamine	55-18-5	Ethanamine, N-ethyl-N-nitroso-	8270	10
N-Nitrosodimethylamine	62-75-9	Methamine, N-methyl-N-nitroso-	8270	10
N-Nitrosodiphenylamine	86-30-6	Benzenamine, N-nitroso-N-phenyl-	8270	10
N-Nitrosodipropylamine; Di-n-propyl- nitrosamine	621-64-7	1-Propanamine, N-nitroso-N-propyl	8270	10
N-Nitrosomethylethylamine	10595-95-6	Ethanamine, N-methyl-N-nitroso-	8270	10
N-Nitrosomorpholine	59-89-2	Morpholine, N-nitroso-	8270	10
N-Nitrosopiperidine	100-75-4	Piperidine, 1-nitroso-	8270	10
N-Nitrosopyrrolidine	930-55-2	Pyrrolidine, 1-nitroso-	8270	10
5-Nitro-o-toluidine	99-55-8	Benzenamine, 2-methyl-5-nitro-	8270	10
Parathion	56-38-2	Phosphorothioic acid, O,O-diethyl-O-(4-nitrophenyl) ester	8270	10
Polychlorinated biphenyls; PCBs	Note 7	1,1'-Biphenyl, chloroderivatives	8080 8250	50 100
Polychlorinated dibenzo-p-dioxins; PCDDs	Note 8	Dibenzo[b,e][1,4]dioxin, chloro derivatives	8280	0.01
Polychlorinated dibenzofurans; PCDFs	Note 9	Dibenzofuran, chloro derivatives	8280	0.01
Pentachlorobenzene	608-93-5	Benzene, pentachloro-	8270	10
Pentachloroethane	76-01-7	Ethane, pentachloro-	8240 8270	5 10
Pentachloronitrobenzene	82-68-8	Benzene, pentachloronitro-	8270	10
Pentachlorophenol	87-86-5	Phenol, pentachloro-	8040 8270	5 50
Phenacetin	62-44-2	Acetamide, N-(4-ethoxyphenyl)-	8270	10
Phenanthrene	85-01-8	Phenanthrene	8100 8270	200 10
Phenol	108-95-2	Phenol	8040 8270	1 10
p-Phenylenediamine	106-50-3	1,4-Benzenediamine	8270	10
Phorate	298-02-2	Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester	8140 8270	2 10
2-Picoline	109-06-8	Pyridine, 2-methyl-	8240 8270	5 10
Pronamide	23950-58-5	Benzamide, 3,5-Dichloro-N-(1,1-dimethyl-2-propynyl)-	8270	10
Propionitrile; Ethyl cyanide	107-12-0	Propanenitrile	8015 8240	60 5
Pyrene	129-00-0	Pyrene	8100 8270	200 10
Pyridine	110-86-1	Pyridine	8240 8270	5 10

**TABLE 2-5**  
**APPENDIX IX PARAMETERS (CONTINUED)**

Common name <sup>2</sup>	CAS RN <sup>3</sup>	Chemical abstracts service index name <sup>4</sup>	Sug- gested methods <sup>5</sup>	PQL (µg/L) <sup>6</sup>
Safrole	94-59-7	1,3-Benzodioxole, 5-(2-propenyl)-	8270	10
Selenium	(Total)	Selenium	6010 7740 7741	750 20 20
Silver	(Total)	Silver	6010 7760	70 100
Silvex; 2,4,5-TP	93-72-1	Propanoic acid, 2-(2,4,5-trichlorophenoxy)-	8150	2
Styrene	100-42-5	Benzene, ethenyl-	8020 8240	1 5
Sulfide	18496-25-8	Sulfide	9030	10,000
2,4,5-T; 2,4,5-Trichlorophenoxy-acetic acid	93-76-5	Acetic acid, (2,4,5-trichlorophenoxy)-	8150	2
2,3,7,8-TCDD; 2,3,7,8-Tetrachlorodiben- zo-p-dioxin	1746-01-6	Dibenxo[b,e][1,4]dioxin, 2,3,7,8-tetrachloro-	8280	0.005
1,2,4,5-Tetrachlorobenzene	95-94-3	Benzene, 1,2,4,5-tetrachloro-	8270	10
1,1,1,2-Tetrachloroethane	630-20-6	Ethane, 1,1,1,2-tetrachloro-	8010 8240	5 5
1,1,2,2-Tetrachloroethane	79-34-5	Ethane, 1,1,2,2-tetrachloro-	8010 8240	0.5 5
Tetrachloroethylene; Perchloroethylene; Tetrachloroethene	127-18-4	Ethene, tetrachloro-	8010 8240	0.5 5
2,3,4,6-Tetrachlorophenol	58-90-2	Phenol, 2,3,4,6-tetrachloro-	8270	10
Tetraethyl dithiopyrophosphate; Sulfotepp	3689-24-5	Thiodiphosphoric acid, [(HO) <sub>2</sub> P(S)] <sub>2</sub> O, tetraethyl ester	8270	10
Thallium	(Total)	Thallium	6010 7840 7841	400 1,000 10
Tin	(Total)	Tin	7870	8,000
Toluene	108-88-3	Benzene, methyl-	8020 8240	2 5
o-Toluidine	95-53-4	Benzenamine, 2-methyl-	8270	10
Toxaphene	8001-35-2	Toxaphene	8080 8250	2 10
1,2,4-Trichlorobenzene	120-82-1	Benzene, 1,2,4-trichloro-	8270	10
1,1,1-Trichloroethane; Methylchloroform	71-55-6	Ethane, 1,1,1-trichloro-	8240	5
1,1,2-Trichloroethane	79-00-5	Ethane, 1,1,2-trichloro-	8010 8240	0.2 5
Trichloroethylene; Trichloroethene	79-01-6	Ethene, trichloro	8010 8240	1 5
Trichlorofluoromethane	75-69-4	Methane, trichlorofluoro-	8010 8240	10 5
2,4,5-Trichlorophenol	95-95-4	Phenol, 2,4,5-trichloro-	8270	10
2,4,6-Trichlorophenol	88-06-2	Phenol, 2,4,6-trichloro-	8040 8270	5 10
1,2,3-Trichloropropane	96-18-4	Propane, 1,2,3-trichloro-	8010 8240	10 5
O,O,O-Triethyl phosphorothioate	126-68-1	Phosphorothioic acid, O,O,O-triethyl ester	8270	10
sym-Trinitrobenzene	99-35-4	Benzene, 1,3,5-trinitro-	8270	10
Vanadium	(Total)	Vanadium	6010 7910 7911	80 2,000 40
Vinyl acetate	108-05-4	Acetic acid, ethenyl ester	8240	5
Vinyl chloride	75-01-4	Ethene, chloro-	8010 8240	2 10
Xylene (total)	1330-20-7	Benzene, dimethyl-	8020 8240	5 5
Zinc	(Total)	Zinc	6010 7950	20 50

**TABLE 2-5**  
**APPENDIX IX PARAMETERS (CONTINUED)**

<sup>1</sup> The regulatory requirements pertain only to the list of substances; the right hand columns (Methods and PQL) are given for informational purposes only. See also footnotes 5 and 6.

<sup>2</sup> Common names are those widely used in government regulations, scientific publications, and commerce; synonyms exist for many chemicals.

<sup>3</sup> Chemical Abstracts Service registry number. Where "Total" is entered, all species in the ground water that contain this element are included.

<sup>4</sup> CAS index names are those used in the 9th Cumulative Index.

<sup>5</sup> Suggested Methods refer to analytical procedure numbers used in EPA Report SW-846 "Test Methods for Evaluating Solid Waste", third edition, November 1986. Analytical details can be found in SW-846 and in documentation on file at the agency. CAUTION: The methods listed are representative SW-846 procedures and may not always be the most suitable method(s) for monitoring an analyte under the regulations.

<sup>6</sup> Practical Quantitation Limits (PQLs) are the lowest concentrations in ground waters that can be reliably determined within specified limits of precision and accuracy by the indicated methods under routine laboratory operating conditions. The PQLs listed are generally stated to one significant figure. CAUTION: The PQL values in many cases are based only on a general estimate for the method and not on a determination for individual compounds; PQLs are not a part of the regulation.

<sup>7</sup> Polychlorinated biphenyls (CAS RN 1336-36-3); this category contains congener chemicals, including constituents of Aroclor-1016 (CAS RN 12674-11-2); Aroclor-1221 (CAS RN 11104-28-2), Aroclor-1232 (CAS RN 11141-16-5), Aroclor-1242 (CAS RN 53469-21-9), Aroclor-1248 (CAS RN 12672-29-6), Aroclor-1254 (CAS RN 11097-69-1), and Aroclor-1260 (CAS RN 11096-82-5). The PQL shown is an average value for PCB congeners.

<sup>8</sup> This category contains congener chemicals, including tetrachlorodibenzo-p-dioxins (see also 2,3,7,8-TCDD), pentachlorodibenzo-p-dioxins, and hexachlorodibenzo-p-dioxins. The PQL shown is an average value for PCDD congeners.

<sup>9</sup> This category contains congener chemicals, including tetrachlorodibenzofurans, pentachlorodibenzofurans, and hexachlorodibenzofurans. The PQL shown is an average value for PCDF congeners.

[52 FR 25946, July 9, 1987]

TABLE 2-6  
PRELIMINARY INVESTIGATION OF CORRECTIVE MEASURES  
WATER TREATABILITY TESTS

Physiochemical

pH  
Conductivity  
Temperature  
Dissolved Oxygen

Major/Minor Ions

Calcium (Ca)  
Magnesium (Mg)  
Sodium (Na)  
Potassium (K)  
Iron (Fe)  
Manganese (Mn)  
Chloride (Cl)  
Sulfate (SO<sub>4</sub>)  
Bicarbonate (HCO<sub>3</sub>)

Corrosion/Encrustation

Langlier Index  
Hydrogen Sulfide (H<sub>2</sub>S)  
Hardness  
Alkalinity  
Silica (H<sub>4</sub>SiO<sub>4</sub>)

POTW/NPDES

Biological Oxygen Demand (BOD)  
Chemical Oxygen Demand (COD)  
Total Suspended Solids (TSS)  
Total Dissolved Solids (TDS)  
Total Petroleum Hydrocarbons (TPHC)  
Oil and Grease  
Total Organic Carbon (TOC)  
Total Organic Halides (TOX)  
Total Kjeldahl Nitrogen (TKN)

Nutrients

Ammonia (NH<sub>4</sub>)  
Nitrate/Nitrite (NO<sub>3</sub>/NO<sub>2</sub>)  
Phosphate (PO<sub>4</sub>)

AM90-112TE  
29 March 1990

TABLE 2-7  
PRELIMINARY INVESTIGATION OF CORRECTIVE MEASURES  
SOIL TREATABILITY TESTS

---

Physiochemical

pH

Cation Exchange Capacity (CEC)

Total Organic Carbon

Infiltration Rate

Major/Minor Ions

Calcium (Ca)

Magnesium (Mg)

Sodium (Na)

Potassium (K)

Iron (Fe)

Manganese (Mn)

Chloride (Cl)

Sulfate (SO<sub>4</sub>)

Bicarbonate (HCO<sub>3</sub>)

Geotechnical

Bulk Density

Particle Size Distribution

Hydraulic Conductivity

o Unsaturated\*

o Saturated

Porosity

Storage Capacity

Characteristics

Total Extraction Procedure Toxicity  
Testing (EP Tox)

Toxicity Characteristic

Leaching Procedure (TCLP)

Nutrients

Ammonia (NH<sub>4</sub>)

Nitrate/Nitrite (NO<sub>3</sub>/NO<sub>2</sub>)

Phosphate (PO<sub>4</sub>)

\* The hydraulic conductivity of soils in the unsaturated zone will be estimated where appropriate from particle size distribution data.

TABLE 2-8  
PRELIMINARY INVESTIGATION OF CORRECTIVE MEASURES  
SURFACE WATER TREATABILITY TESTS

---

Physiochemical

pH ✓  
Conductivity ✓  
Temperature  
Dissolved Oxygen ✓

Major/Minor Ions

Calcium (Ca)  
Magnesium (Mg)  
Sodium (Na)  
Potassium (K)  
Iron (Fe)  
Manganese (Mn)  
Chloride (Cl)  
Sulfate (SO<sub>4</sub>)  
Bicarbonate (HCO<sub>3</sub>)

NPDES

Biological Oxygen Demand (BOD) ✓  
Chemical Oxygen Demand (COD) ✓  
Total Suspended Solids (TSS) ✓  
Total Dissolved Solids (TDS) ✓  
Total Organic Carbon (TOC)  
Alkalinity ✓

Nutrients

Ammonia (NH<sub>4</sub>) ✓  
Nitrate/Nitrite (NO<sub>3</sub>/NO<sub>2</sub>) ✓  
Phosphate (PO<sub>4</sub>) ✓

AM90-112TZ

TABLE 2-9  
PRELIMINARY INVESTIGATION OF CORRECTIVE MEASURES  
SEDIMENT TREATABILITY TESTS

---

Physiochemical

pH  
Cation Exchange Capacity (CEC)  
Total Organic Carbon

Geotechnical

Bulk Density  
Particle Size Distribution  
Porosity

Major/Minor Ions

Calcium (Ca)  
Magnesium (Mg)  
Sodium (Na)  
Potassium (K)  
Iron (Fe)  
Manganese (Mn)  
Chloride (Cl)  
Sulfate (SO<sub>4</sub>)  
Bicarbonate (HCO<sub>3</sub>)

Nutrients

Ammonia (NH<sub>4</sub>)  
Nitrate/Nitrite (NO<sub>3</sub>/NO<sub>2</sub>)  
Phosphate (PO<sub>4</sub>)

AM90-112TX

TABLE 3-1  
PHYSICAL SITE CHARACTERIZATION STUDY (PHASE 1A)  
GEOLOGIC CHARACTERIZATION PROGRAM  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Location	Study Area	Sample Media	Sampling Method	Sample Type	Estimated Sampling Interval	Number of Samples	Screening
Boring RW-1	Production Area	Soil/Rock	Split Spoon/Core	Grab	Continuous (ground surface to 20 feet into rock)	54	Visual classification; organic vapor screening
						3	Geotechnical laboratory tests*
Boring RW-2	Waste Water Treatment Area	Soil/Rock	Split Spoon/Core	Grab	Continuous (ground surface to 20 feet into rock)	54	Visual classification; organic vapor screening
						3	Geotechnical laboratory tests*
Boring RW-3	Warwick Area	Soil/Rock	Split Spoon/Core	Grab	Continuous (ground surface to 20 feet into rock)	54	Visual classification; organic vapor screening
						3	Geotechnical laboratory tests*
Boring RW-4	Between Production and Waste Water Treatment Areas	Soil/Rock	Split Spoon/Core	Grab	Continuous (ground surface to 20 feet into rock)	54	Visual classification; organic vapor screening
						3	Geotechnical laboratory tests*

\* Soil sampled from the unsaturated and saturated zones will undergo geotechnical testing (see Section 2.5.2 and 2.6). Soil collected with split-spoon samplers (in the unsaturated and saturated zones) will be analyzed for particle size distribution. Soil collected with shelly tubes samplers (saturated zone only) will be analyzed for particle size distribution, bulk density, porosity, and hydraulic conductivity.



TABLE 3-1 (Continued)  
 PHYSICAL SITE CHARACTERIZATION STUDY (PHASE 1A)  
 GEOLOGIC CHARACTERIZATION PROGRAM  
 CIBA-GEIGY FACILITY  
 CRANSTON, RHODE ISLAND

Revision No. 3  
 27 Nov. 1990

Location	Study Area	Sample Media	Sampling Method	Sample Type	Estimated Sampling Interval	Number of Samples	Screening
Boring P-19D	Waste Water Treatment area	Soil	Split Spoon	Grab	Continuous (ground surface to confining layer or bedrock)	25	Visual classification; organic vapor screening
						2	Geotechnical laboratory tests*
Boring P-21D	Warwick Area	Soil	Split Spoon	Grab	Continuous (ground surface to confining layer or bedrock)	25	Visual classification; organic vapor screening
						2	Geotechnical laboratory tests*
Boring P-22D	Warwick Area	Soil	Split Spoon	Grab	Continuous (ground surface to confining layer or bedrock)	25	Visual classification; organic vapor screening
						2	Geotechnical laboratory tests*
Boring MW-10S	Production Area	Soil	Split Spoon	Grab	Continuous (ground surface to 8 feet below ground water table)	10	Visual classification; organic vapor screening

\* Soil sampled from the unsaturated and saturated zones will undergo geotechnical testing (see Section 2.5.2 and 2.6). Soil collected with split-spoon samplers (in the unsaturated and saturated zones) will be analyzed for particle size distribution. Soil collected with shelly tubes samplers (saturated zone only) will be analyzed for particle size distribution, bulk density, porosity, and hydraulic conductivity.

TABLE 3-1 (Continued)  
 PHYSICAL SITE CHARACTERIZATION STUDY (PHASE 1A)  
 GEOLOGIC CHARACTERIZATION PROGRAM  
 CIBA-GEIGY FACILITY  
 CRANSTON, RHODE ISLAND

Revision No. 2  
 19 Oct. 1990

Location	Study Area	Sample Media	Sampling Method	Sample Type	Estimated Sampling Interval	Number of Samples	Screening
Boring MW-10D	Production Area	Soil	Split Spoon	Grab	Continuous (ground surface to confining layer or bedrock)	25	Visual classification; organic vapor screening
Boring MW-11S	Warwick Area	Soil	Split Spoon	Grab	Continuous (ground surface to 8 feet below ground water table)	8	Visual classification; organic vapor screening
Boring MW-12S	Production Area	Soil	Split Spoon	Grab	Continuous (ground surface to 8 feet below ground water table)	10	Visual classification; organic vapor screening
Boring MW-13S	Production Area	Soil	Split Spoon	Grab	Continuous (ground surface to 8 feet below ground water table)	9	Visual classification; organic vapor screening
Boring MW-14S	Production Area	Soil	Split Spoon	Grab	Continuous (ground surface to 8 feet below ground water table)	10	Visual classification; organic vapor screening

TABLE 3-1 (Continued)  
 PHYSICAL SITE CHARACTERIZATION STUDY (PHASE 1A)  
 GEOLOGIC CHARACTERIZATION PROGRAM  
 CIBA-GEIGY FACILITY  
 CRANSTON, RHODE ISLAND

Revision No. 2  
 19 Oct. 1990

Location	Study Area	Sample Media	Sampling Method	Sample Type	Estimated Sampling Interval	Number of Samples	Screening
Boring MW-15S	Production Area	Soil	Split Spoon	Grab	Continuous (ground surface to 8 feet below ground water table)	8	Visual classification; organic vapor screening
Boring MW-15D	Production Area	Soil	Split Spoon	Grab	Continuous (ground surface to confining layer or bedrock)	23	Visual classification; organic vapor screening
Boring MW-16S	Production Area	Soil	Split Spoon	Grab	Continuous (ground surface to 8 feet below ground water table)	10	Visual classification; organic vapor screening
Boring MW-16D	Production Area	Soil	Split Spoon	Grab	Continuous (ground surface to confining layer or bedrock)	25	Visual classification; organic vapor screening
Boring MW-17S	Warwick Area	Soil	Split Spoon	Grab	Continuous (ground surface to 8 feet below ground water table)	8	Visual classification; organic vapor screening
Boring MW-17D	Warwick Area	Soil	Split Spoon	Grab	Continuous (ground surface to confining layer or bedrock)	25	Visual classification; organic vapor screening

TABLE 3-2  
PHYSICAL SITE CHARACTERIZATION STUDY (PHASE 1A)  
HYDROGEOLOGIC CHARACTERIZATION PROGRAM  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Well Number	Study Area	Depth of Screened Interval (feet)	Strata Monitored	Field Measurement	Number of Measurements
<b><u>Proposed Piezometers and Wells</u></b>					
P-15S	Warwick Area	9-12	Unconsolidated Deposits	Slug Test Water Level	1 1 per quarter
P-16S	Warwick Area	10-13	Unconsolidated Deposits	Slug Test Water Level	1 1 per quarter
P-17S	Warwick Area	10-13	Unconsolidated Deposits	Slug Test Water Level	1 1 per quarter
P-18D	Warwick Area	50-53	Unconsolidated Deposits	Slug Test Water Level	1 1 per quarter
P-19D	Waste Water Treatment Area	50-53	Unconsolidated Deposits	Slug Test Water Level	1 1 per quarter
P-20S	Between Production and Waste Water Treatment Areas	9-12	Unconsolidated Deposits	Slug Test Water Level	1 1 per quarter
P-20D	Between Production and Waste Water Treatment Areas	50-53	Unconsolidated Deposits	Slug Test Water Level	1 1 per quarter
P-21S	Warwick Area	9-12	Unconsolidated Deposits	Slug Test Water Level	1 1 per quarter
P-21D	Warwick Area	49-52	Unconsolidated Deposits	Slug Test Water Level	1 1 per quarter
P-22S	Warwick Area	10-13	Unconsolidated Deposits	Slug Test Water Level	1 1 per quarter
P-22D	Warwick Area	50-53	Unconsolidated Deposits	Slug Test Water Level	1 1 per quarter

TABLE 3-2 (continued)  
**PHYSICAL SITE CHARACTERIZATION STUDY (PHASE 1A)**  
**HYDROGEOLOGIC CHARACTERIZATION PROGRAM**  
**CIBA-GEIGY FACILITY**  
**CRANSTON, RHODE ISLAND**

Well Number	Study Area	Depth of Screened Interval (feet)	Strata Monitored	Field Measurements	Number of Measurements
RW-1	Production Area	100-110	Bedrock	Slug Test Water Level	1 1 per quarter
RW-2	Waste Water Treatment Area	100-110	Bedrock	Slug Test Water Level	1 1 per quarter
RW-3	Warwick Area	100-110	Bedrock	Slug Test Water Level	1 1 per quarter
RW-4	Between Production and Waste Water Treatment Areas	100-110	Bedrock	Slug Test Water Level	1 1 per quarter
<b>Existing Piezometers and Wells</b>					
P-1S	Production Area	7-10	Fill	Water Level	1 per quarter
P-1D	Production Area	40-43	Unconsolidated Deposits	Water Level	1 per quarter
P-2S	Production Area	8-11	Fill	Water Level	1 per quarter
P-3S	Production Area	8.5-11.5	Fill	Water Level	1 per quarter
P-4S	Production Area	15-18	Unconsolidated Deposits	Water Level	1 per quarter
P-5S	Production Area	13-16	Unconsolidated Deposits	Water Level	1 per quarter
P-6S	Production Area	15-18	Unconsolidated Deposits	Water Level	1 per quarter
P-6M	Production Area	37-40	Unconsolidated Deposits	Water Level	1 per quarter
P-7S-A	Waste Water Treatment Area	6-9	Unconsolidated Deposits	Water Level	1 per quarter
P-7S-B	Waste Water Treatment Area	11-14	Unconsolidated Deposits	Water Level	1 per quarter

TABLE 3-2 (continued)  
 PHYSICAL SITE CHARACTERIZATION STUDY (PHASE 1A)  
 HYDROGEOLOGIC CHARACTERIZATION PROGRAM  
 CIBA-GEIGY FACILITY  
 CRANSTON, RHODE ISLAND

Well Number	Study Area	Depth of Screened Interval (feet)	Strata Monitored	Field Measurements	Number of Measurements
P-8S	Waste Water Treatment Area	8.5-11.5	Unconsolidated Deposits	Water Level	1 per quarter
P-9S	Waste Water Treatment Area	9-12	Unconsolidated Deposits	Water Level	1 per quarter
P-10S	Warwick Area	9-12	Unconsolidated Deposits	Water Level	1 per quarter
P-11S	Waste Water Treatment Area	7-10	--	Water Level	1 per quarter
P-12S-A	Waste Water Treatment Area	9-12	--	Water Level	1 per quarter
P-12S-B	Waste Water Treatment Area	12-15	--	Water Level	1 per quarter
P-13S	Production Area	11-14	--	Water Level	1 per quarter
P-14S	Production Area	10-13	Unconsolidated Deposits	Water Level	1 per quarter
P-14D	Production Area	47-50	Till	Water Level	1 per quarter
EP-1	Production Area	--	--	Water Level	1 per quarter
EP-2	Atlantic Tubing & Rubber	--	--	Water Level	1 per quarter
EP-5	Warwick Area	--	--	Water Level	1 per quarter
EP-6	Warwick Area	--	--	Water Level	1 per quarter
EP-8	Atlantic Tubing & Rubber	--	--	Water Level	1 per quarter

TABLE 3-2 (continued)  
PHYSICAL SITE CHARACTERIZATION STUDY (PHASE IA)  
HYDROGEOLOGIC CHARACTERIZATION PROGRAM  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Well Number	Study Area	Depth of Screened Interval (feet)	Strata Monitored	Field Measurements	Number of Measurements
MW-1S	Production Area	3-13	Fill	Water Level	1 per quarter
MW-1D	Production Area	38-48	Unconsolidated Deposits	Water Level	1 per quarter
MW-2S	Production Area	8-18	Fill	Water Level	1 per quarter
MW-3S	Production Area	8-18	Fill/Unconsolidated Deposits	Water Level	1 per quarter
MW-4S	Production Area	6-16	Fill/Unconsolidated Deposits	Water Level	1 per quarter
MW-5S	Production Area	6-16	Unconsolidated Deposits	Water Level	1 per quarter
MW-6S	Warwick Area	3.5-13.5	Unconsolidated Deposits	Water Level	1 per quarter
MW-7S	Waste Water Treatment Area	8-18	--	Water Level	1 per quarter
MW-8S	Waste Water Treatment Area	5.5-15.5	Fill/Unconsolidated Deposits	Water Level	1 per quarter
MW-9S	Waste Water Treatment Area	3-13	Fill/Unconsolidated Deposits	Water Level	1 per quarter

Notes:

- 1) Depth of screened interval of proposed wells and piezometers may vary depending on stratigraphy encountered during drilling.
- 2) Quarterly monitoring of water levels will continue until preparation of the Phase II Report begins.
- 3) -- = information not available

7 Sept. 1990

**TABLE 3-3**  
**PHYSICAL SITE CHARACTERIZATION STUDY (PHASE IA)**  
**HYDROLOGIC CHARACTERIZATION PROGRAM**  
**CIBA-GEIGY FACILITY**  
**CRANSTON, RHODE ISLAND**

Sample Location/ Sample Number	Interval (feet)	Sample Medium	Sampling Technique	Analysis
SDF02R	0-1	Bed Sediment	Core	Particle size distribution, bulk density, cation exchange capacity, pH, porosity, TOC
SDF03R	0-1	Bed Sediment	Core	Particle size distribution, bulk density, cation exchange capacity, pH, porosity, TOC
SDF05L	0-1	Bed Sediment	Core	Particle size distribution, bulk density, cation exchange capacity, pH, porosity, TOC
SDF06L	0-1	Bed Sediment	Core	Particle size distribution, bulk density, cation exchange capacity, pH, porosity, TOC
SDF07R	0-1	Bed Sediment	Core	Particle size distribution, bulk density, cation exchange capacity, pH, porosity, TOC
SDF08R	0-1	Bed Sediment	Core	Particle size distribution, bulk density, cation exchange capacity, pH, porosity, TOC
Transects to be established after the bathymetric survey has been conducted	Surface to bottom	Surface Water	Pump	TSS (suspended sediment)

Notes: Analyte Lists are described in Section 2.6.



TABLE 4-1  
PROPOSED PHASE 1B RELEASE CHARACTERIZATION SAMPLING SUMMARY  
CIBA - GEIGY  
CRANSTON, RHODE ISLAND

UNIT	MEDIA					PARAMETERS				
	SOIL	GROUND WATER	SURFACE WATER	SEDIMENT		APPENDIX A	FINGERPRINT COMPOUNDS	MAJOR IONS	TREATABILITY	TARGET COMPOUNDS
SWMU1	NR	NR	NR	NR						
SWMU2	3 3	2 2	NR	NR						
SWMU3 <sup>(1)</sup>	3 3	2 2	NR	NR						
SWMU4	NR	NR	NR	NR						
SWMU5	5 5	3 3	NR	NR						
SWMU6	1 6	NR	NR	NR						
SWMU7	2 2	1 1	NR	NR						
SWMU8	2 2	2 2	NR	NR						
SWMU9	3 3	NR	*	*						
SWMU10 <sup>(2)</sup>	3 3	4 4	1 1	2 2						
SWMU11	2 2	1 1	NR	NR						
SWMU12	4 4	4 4	*	*						
AOC13 <sup>(3)</sup>	1 1	15 15	NR	NR						
AOC14	NR	NR	NR	NR						
AOC15	1 2	2 2	NR	NR						
AOC16	1 2	2 2	NR	NR						
OFF-SITE	0 14	NR	NR	NR						
BACKGROUND OFF-SITE	4 4	NR	NR	NR						
RIVER	NR	NR	7 7	9						

**NOTES:**

- (1). SURFACE WATER AND SEDIMENT SAMPLES WILL BE COLLECTED FROM THE POND LOCATED IN THE WASTE WATER TREATMENT AREA.
- (2). SAMPLES ARE COMMON TO SWMU2, SWMU3, SWMU7, SWMU8, AND SWMU11.

TBD - BACKGROUND SAMPLING LOCATIONS FOR SURFACE WATER, SEDIMENT, AND GROUND WATER WILL BE DETERMINED IN CONSULTATION WITH EPA

**LEGEND:**

SOIL GROUND WATER  
SEDIMENT SURFACE WATER

SHADED AREAS INDICATE MEDIA OF CONCERN TO BE INVESTIGATED

NR - NOT REQUIRED

\* - ADDRESSED IN THE RIVER SECTION

NUMBER OF SAMPLES COLLECTED IN ROUND 1  
NUMBER OF SAMPLES COLLECTED IN ROUND 2

TABLE 4-2  
RELEASE CHARACTERIZATION PROGRAM (PHASE 1B)  
MEDIA OF CONCERN SAMPLING SUMMARY  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Location	Sample Identification	Media	Sampling Method	Sample Type	Sample Depth or Screened Interval (feet)	Analysis
SWMU-2	B-2A B-2B	Soil	Split Spoon	Grab	9-11	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Geotechnical, Characteristics, and Nutrients Lists
SWMU-3	B-3A B-3B	Soil	Split Spoon	Grab	9-11	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Geotechnical, Characteristics, and Nutrients Lists
AOC-13	SS-13A SS-13B SS-13C SS-13D SS-13E SS-13F SS-13G SS-13H SS-13I SS-13J	Soil	Trowel/ Shallow Boring	Grab	0.5-1	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Geotechnical, Characteristics, and Nutrients Lists
SWMU-5	SS-5A SS-5B SS-5C SS-5D SS-5E	Soil	Trowel/ Shallow Boring	Grab	0.5-1	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Geotechnical, Characteristics, and Nutrients Lists
SWMU-6	SS-6A	soil	Trowel	Grab	0.5-1.0	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Geotechnical, Characteristics, and

TABLE 4-2 (continued)  
RELEASE CHARACTERIZATION PROGRAM (PHASE 1B)  
MEDIA OF CONCERN SAMPLING SUMMARY  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Location	Sample Identification	Media	Sampling Method	Sample Type	Sample Depth or Screened Interval (feet)	Analysis
SWMU-7	B-7A B-7B	Soil	Split Spoon	Grab	9-11	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions Geotechnical, Characteristics, and Nutrients Lists
SWMU-8	B-8A B-8B	Soil	Split Spoon	Grab	9-11	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions Geotechnical, Characteristics, and Nutrients Lists
SWMU-9	SS-9A SS-9B SS-9C	Soil	Trowel/ Shallow Boring	Grab	0.5-1.0	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions Geotechnical, Characteristics and Nutrients Lists
SWMU-10	B-10A B-10B B-10C	Soil	Split Spoon	Grab	8-10	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions Geotechnical, Characteristics and Nutrients Lists
SWMU-11	B-11A B-11B	Soil	Split Spoon	Grab	9-11	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions Geotechnical, Characterization, and Nutrients Lists
SWMU-12	SS-12A SS-12B SS-12C SS-12D	Soil	Trowel/ Shallow Boring	Grab	0.5-2.0	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Geotechnical, Characteristics, and Nutrients Lists

TABLE 4-2 (continued)  
RELEASE CHARACTERIZATION PROGRAM (PHASE 1B)  
MEDIA OF CONCERN SAMPLING SUMMARY  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Location	Sample Identification	Media	Sampling Method	Sample Type	Sample Depth or Screened Interval (feet)	Analysis
AAOI-15	B-15A	Soil	Split Spoon	Grab	8-10	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions Geotechnical, Characterization, and Nutrients Lists
AAOI-16	B-16A	Soil	Split Spoon	Grab	8-10	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions Geotechnical, Characterization, and Nutrients Lists
SWMUs 2 and 3, AOC-13	MW-10S	Ground Water	Bailer	Grab	10-20	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Corrosion/Encrustation, POTW/NPDES, and Nutrients Lists
SWMUs 2 and 3, AOC-13	MW-10D	Ground Water	Bailer	Grab	40-50	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Corrosion/Encrustation, POTW/NPDES, and Nutrients Lists
SWMU-5	MW-11S RW-3 MW-6S	Ground Water	Bailer	Grab	5-15 100-110 3.5-13.5	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Corrosion/Encrustation, POTW/NPDES, and Nutrients Lists
SWMU-7	MW-12S	Ground Water	Bailer	Grab	10-20	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Corrosion/Encrustation, POTW/NPDES, and Nutrients Lists

TABLE 4-2 (continued)  
RELEASE CHARACTERIZATION PROGRAM (PHASE 1B)  
MEDIA OF CONCERN SAMPLING SUMMARY  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Location	Sample Identification	Media	Sampling Method	Sample Type	Sample Depth or Screened Interval (feet)	Analysis
SWMU-8	MW-13S	Ground Water	Bailer	Grab	7-17	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Corrosion/Encrustation, POTW/NPDES, and Nutrients Lists
SWMU-10	MW-7S MW-8S MW-9S RW-2	Ground Water	Bailer	Grab	8-18	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Corrosion/Encrustation, POTW/NPDES, and Nutrients Lists
SWMU-11	MW-14S	Ground Water	Bailer	Grab	10-20	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Corrosion/Encrustation, POTW/NPDES, and Nutrients Lists
SWMU-12	MW-7S MW-8S MW-9S RW-2	Ground Water	Bailer	Grab	8-18 5.5-15.5 3-13 100-110	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Corrosion/Encrustation, POTW/NPDES, and Nutrients Lists

TABLE 4-2 (continued)  
RELEASE CHARACTERIZATION PROGRAM (PHASE 1B)  
MEDIA OF CONCERN SAMPLING SUMMARY  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Location	Sample Identification	Media	Sampling Method	Sample Type	Sample Depth or Screened Interval (feet)	Analysis
AOC-13	MW-1S	Ground Water	Bailer	Grab	3-13	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Corrosion/Encrustation, POTW/NPDES, and Nutrients Lists
	MW-1D				38-48	
	MW-2S				8-18	
	MW-3S				8-18	
	MW-4S				6-16	
	MW-5S				6-16	
	MW-10S				10-20	
	MW-10D				40-50	
	MW-12S				10-20	
	MW-13S				7-17	
	MW-14S				10-20	
	MW-16S				10-20	
	MW-16D				40-50	
	RW-1				100-110	
	RW-4				100-110	
AAOI-15	MW-16S	Ground Water	Bailer	Grab	10-20	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Corrosion/Encrustation, POTW/NPDES, and Nutrients Lists
	MW-16D				40-50	
AAOI-16	MW-17S	Ground Water	Bailer	Grab	5-15	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Corrosion/Encrustation, POTW/NPDES, and Nutrients Lists
	MW-17D					
Waste Water Treatment Area Pond	PSD-1 PSD-2	Sediment	Hand Corer	Grab	0-1	Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Geotechnical, and Nutrients Lists

TABLE 4-2 (continued)  
RELEASE CHARACTERIZATION PROGRAM (PHASE 1B)  
MEDIA OF CONCERN SAMPLING SUMMARY  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Location	Sample Identification	Media	Sampling Method	Sample Type	Sample Depth or Screened Interval (feet)	Analysis
Waste Water Treatment Area Pond	PSW-1	Surface Water	Dip	Grab		Appendix IX, Fingerprint Compounds, Physicochemical, Major/Minor Ions, Corrosion/Encrustation, POTW/NPDES, and Nutrients Lists

NOTES: All on-site Media of Concern will be sampled twice in Phase 1B. For both sampling rounds (Round 1 and Round 2), Media of concern will be analyzed for Appendix IX compounds, fingerprint compounds, major ions, and treatability parameters. The justification and description of the analyte lists is presented in Section 2.6.

For all soil sampling events, priority will be given to samples collected for chemical analysis (e.g. Appendix IX and fingerprint compounds). If sufficient soil quantities are not available from the proposed sample interval, additional sample will be collected from the adjacent upper and lower soil horizons.

Some samples will be used to characterize multiple SWMUs.

7 Sept. 1990

TABLE 4-3  
OFF-SITE SOIL SAMPLING SUMMARY  
RELEASE CHARACTERIZATION PROGRAM (PHASE IB)  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Sample Location	Sample Media	Sampling Method	Sample Type	Sample Interval (inches)	Analysis <sup>(1)</sup>
Park View Jr. High School	Soil	Trowel	Grab	6-12	Target Compounds
Fay Field	Soil	Trowel	Grab	6-12	Target Compounds
Beechmont Recreational Field	Soil	Trowel	Grab	6-12	Target Compounds
Roger Williams Park	Soil	Trowel	Grab	6-12	Target Compounds
Park Avenue Elderly Housing	Soil	Trowel	Grab	6-12	Target Compounds
Cranston General Hospital	Soil	Trowel	Grab	6-12	Target Compounds
Hall Manor Elderly Housing	Soil	Trowel	Grab	6-12	Target Compounds
Scandanavian Nursing Home	Soil	Trowel	Grab	6-12	Target Compounds
Edgewood Highland School	Soil	Trowel	Grab	6-12	Target Compounds
Norwood Avenue School	Soil	Trowel	Grab	6-12	Target Compounds
Beechmont School	Soil	Trowel	Grab	6-12	Target Compounds
Sprague Playground <sup>(2)</sup>	Soil	Trowel	Grab	6-12	Target Compounds
Aldrich Jr. High School <sup>(2)</sup>	Soil	Trowel	Grab	6-12	Target Compounds
Christopher Rhodes School <sup>(2)</sup>	Soil	Trowel	Grab	6-12	Target Compounds

NOTES: (1) Target compounds will be selected from the list of chemicals found on-site during the first sampling event.

(2) Additional sampling locations identified by CIBA-GEIGY.



TABLE 4-4  
BACKGROUND SOIL SAMPLING SUMMARY  
RELEASE CHARACTERIZATION PROGRAM (PHASE IB)  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Location	Sample Media	Sampling Method	Sample Type	Sample Interval (inches)	Number of Samples	Analysis
Belmont Park, Warwick	Soil	Trowel	Grab	6-12	2	Appendix IX compounds, fingerprint compounds
New Dutenple School, Cranston	Soil	Trowel	Grab	6-12	2	Appendix IX compounds, fingerprint compounds
Pilgrim High School, Pilgrim Park	Soil	Trowel	Grab	6-12	2	Appendix IX compounds, fingerprint compounds
Wyman School, Warwick	Soil	Trowel	Grab	6-12	2	Appendix IX compounds, fingerprint compounds

NOTE: Analyte Lists are described in Section 2.6

TABLE 4-5

**SURFACE WATER AND SEDIMENT  
SUMMARY OF THE RELEASE CHARACTERIZATION PROGRAM  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND**

Sample Location/ Sample Number	Sample Medium	Sampling Technique	Interval (ft)	Analysis
<b>BED SEDIMENT SAMPLES</b>				
SDF00M	Bed Sediment	Core	0-1	Appendix IX, Fingerprint, Physicochemical Major/Minor Ions, Geotechnical and Nutrient Lists
SDF01M	Bed Sediment	Core	0-1	Appendix IX, Fingerprint, Physicochemical Major/Minor Ions, Geotechnical and Nutrient Lists
SDF02R	Bed Sediment	Core	0-1	Appendix IX, Fingerprint, Physicochemical, Major/Minor Ions, Geotechnical and Nutrient Lists
SDF03R	Bed Sediment	Core	0-1	Appendix IX, Fingerprint, Physicochemical, Major/Minor Ions, Geotechnical and Nutrient Lists
SDF05L	Bed Sediment	Core	0-1	Appendix IX, Fingerprint, Physicochemical, Major/Minor Ions, Geotechnical and Nutrient Lists
SDF06L	Bed Sediment	Core	0-1	Appendix IX, Fingerprint, Physicochemical, Major/Minor Ions, Geotechnical and Nutrient Lists
SDF07R	Bed Sediment	Core	0-1	Appendix IX, Fingerprint, Physicochemical, Major/Minor Ions, Geotechnical and Nutrient Lists

TABLE 4-5 (continued)  
SURFACE WATER AND SEDIMENT  
SUMMARY OF THE RELEASE CHARACTERIZATION PROGRAM  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

Sample Location/ Sample Number	Sample Medium	Sampling Technique	Interval (ft)	Analysis
SDF08R	Bed Sediment	Core	0-1	Appendix IX, Fingerprint, Physicochemical, Major/Minor Ions, Geotechnical and Nutrient Lists
SDF10M	Bed Sediment	Core	0-1	Appendix IX, Fingerprint, Physicochemical, Major/Minor Ions, Geotechnical and Nutrient Lists
SURFACE WATER SAMPLES				
SWF01M	Surface Water	Dip	Surface	Appendix IX and Fingerprint Compounds detected in samples SWF04M through SWF09M. Also analyzed for TSS and TOC. Field-filtered and -unfiltered samples will be submitted.
SWF04M	Surface Water	Dip	Surface	Appendix IX, Fingerprint, Physicochemical, Major/Minor Ions, NPDES and Nutrients Lists
SWF06M	Surface Water	Dip	Surface	Appendix IX, Fingerprint, Physicochemical, Major/Minor Ions, NPDES and Nutrients Lists
SWF07M	Surface Water	Dip	Surface	Appendix IX, Fingerprint, Physicochemical, Major/Minor Ions, NPDES and Nutrients Lists

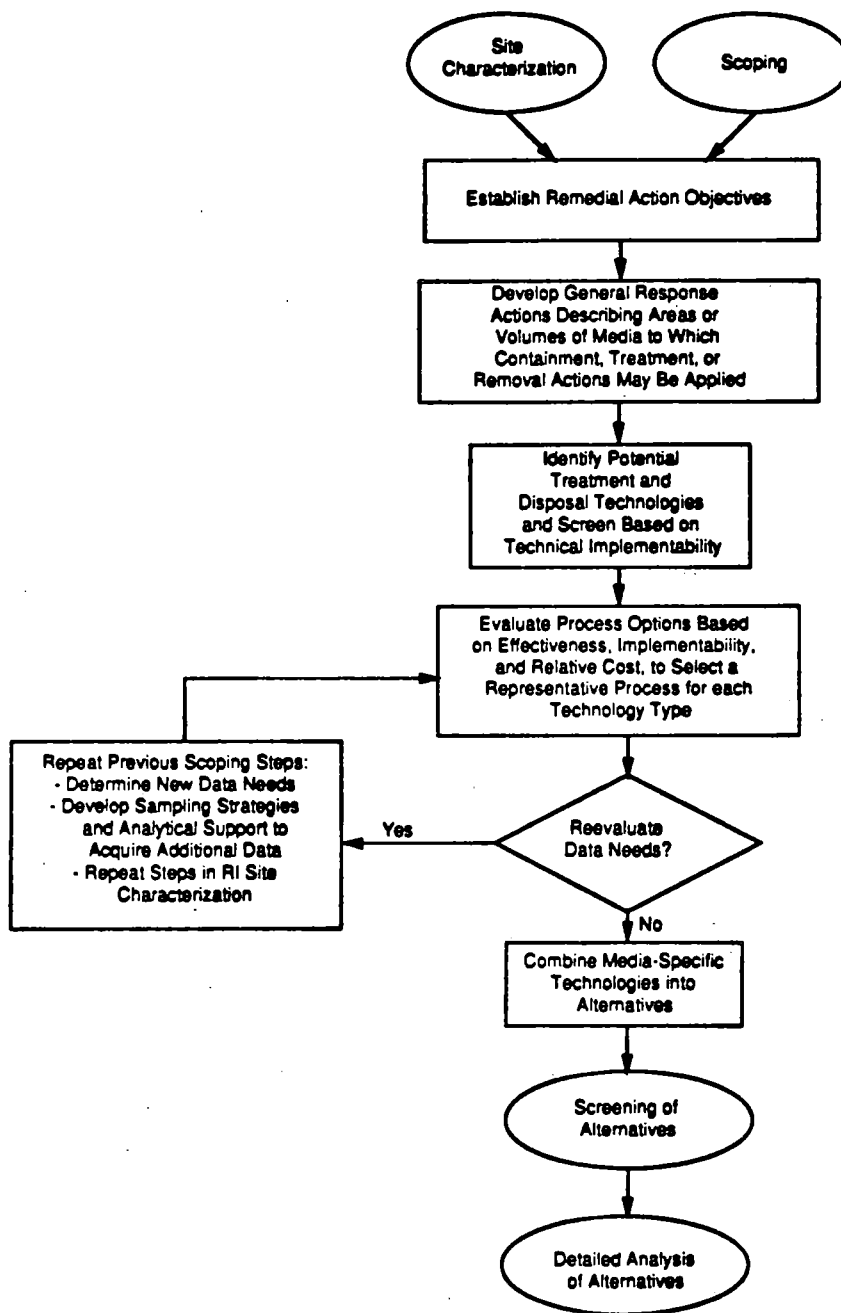
**TABLE 4-5 (Continued)**  
**SURFACE WATER AND SEDIMENT**  
**SUMMARY OF THE RELEASE CHARACTERIZATION PROGRAM**  
**CIBA-GEIGY FACILITY**  
**CRANSTON, RHODE ISLAND**

Sample Location/ Sample Number	Sample Medium	Sampling Technique	Interval (ft)	Analysis <sup>1</sup>
SWF08M	Surface Water	Dip	Surface	Appendix IX, Fingerprint, Physicochemical, Major/Minor Ions, NPDES and Nutrients Lists
SWF09M	Surface Water	Dip	Surface	Appendix IX, Fingerprint, Physicochemical, Major/Minor Ions, NPDES and Nutrients Lists
SWF10M	Surface Water	Dip	Surface	Analyze for Appendix IX and fingerprint detected in samples SWF04M through SWF09M. Also analyzed for TSS and TOC. Field-filtered and unfiltered samples will be submitted.

**Notes:**

1. Analysis is to be consistent with Sections 2.5.4 and 2.5.5 and Tables 2-8 and 2-9.
2. Surface water samples will be collected under base flow and storm flow conditions.

## **Figures**



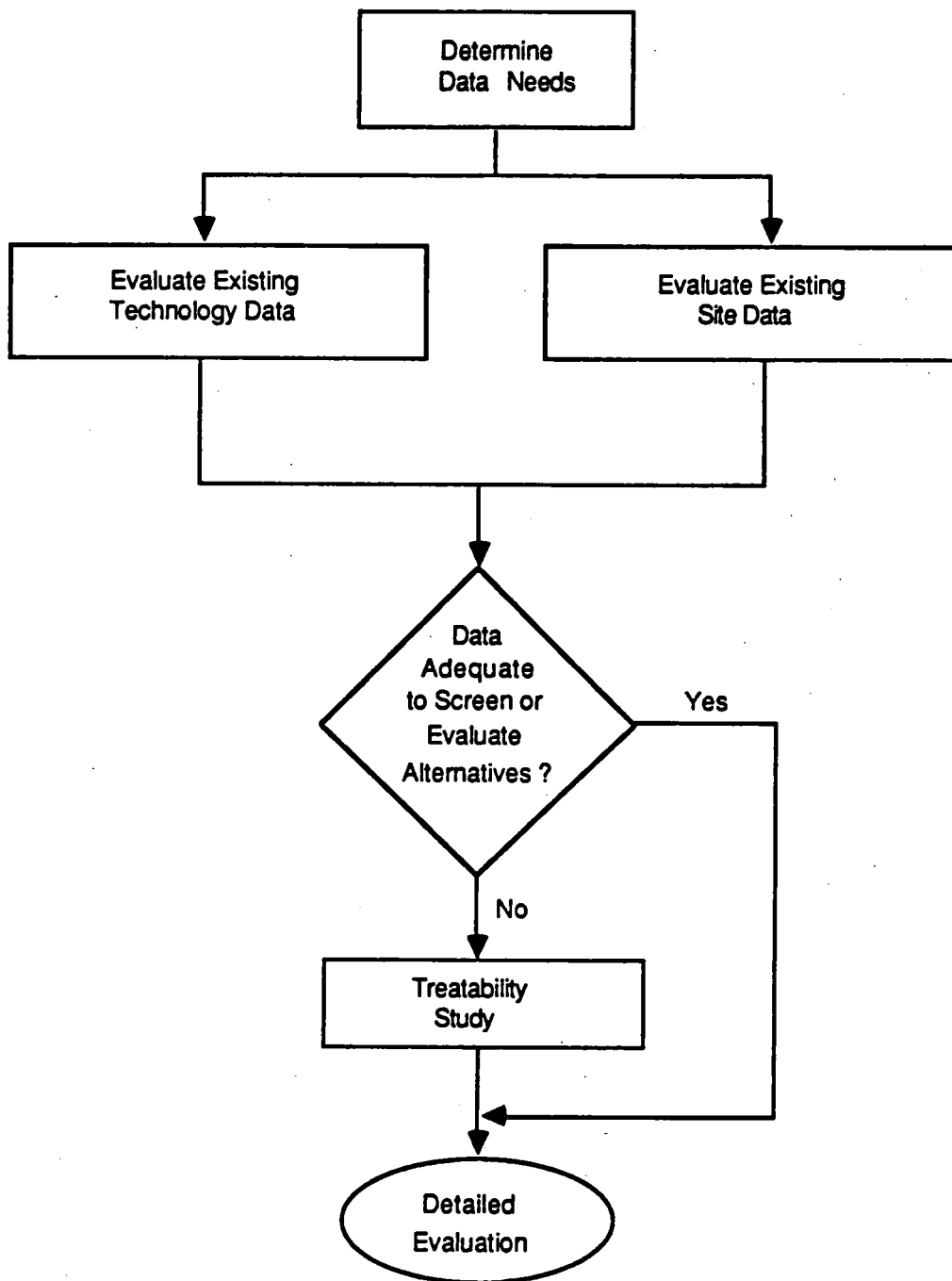
**SOURCE:**  
GUIDANCE FOR CONDUCTING REMEDIAL  
INVESTIGATIONS AND FEASIBILITY STUDIES  
UNDER CERCLA (INTERIM FINAL) (EPA, 1988).

**GENERAL PROGRESSION  
FOR ALTERNATIVE DEVELOPMENT  
OF MEDIA PROTECTION STANDARDS  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND**

**WOODWARD - CLYDE CONSULTANTS**

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

DR. BY: FWD	SCALE: NONE	PROJ. NO: 87X4660
CK'D BY: AW	DATE: JAN 23 1991	FIG. NO.: 2-1



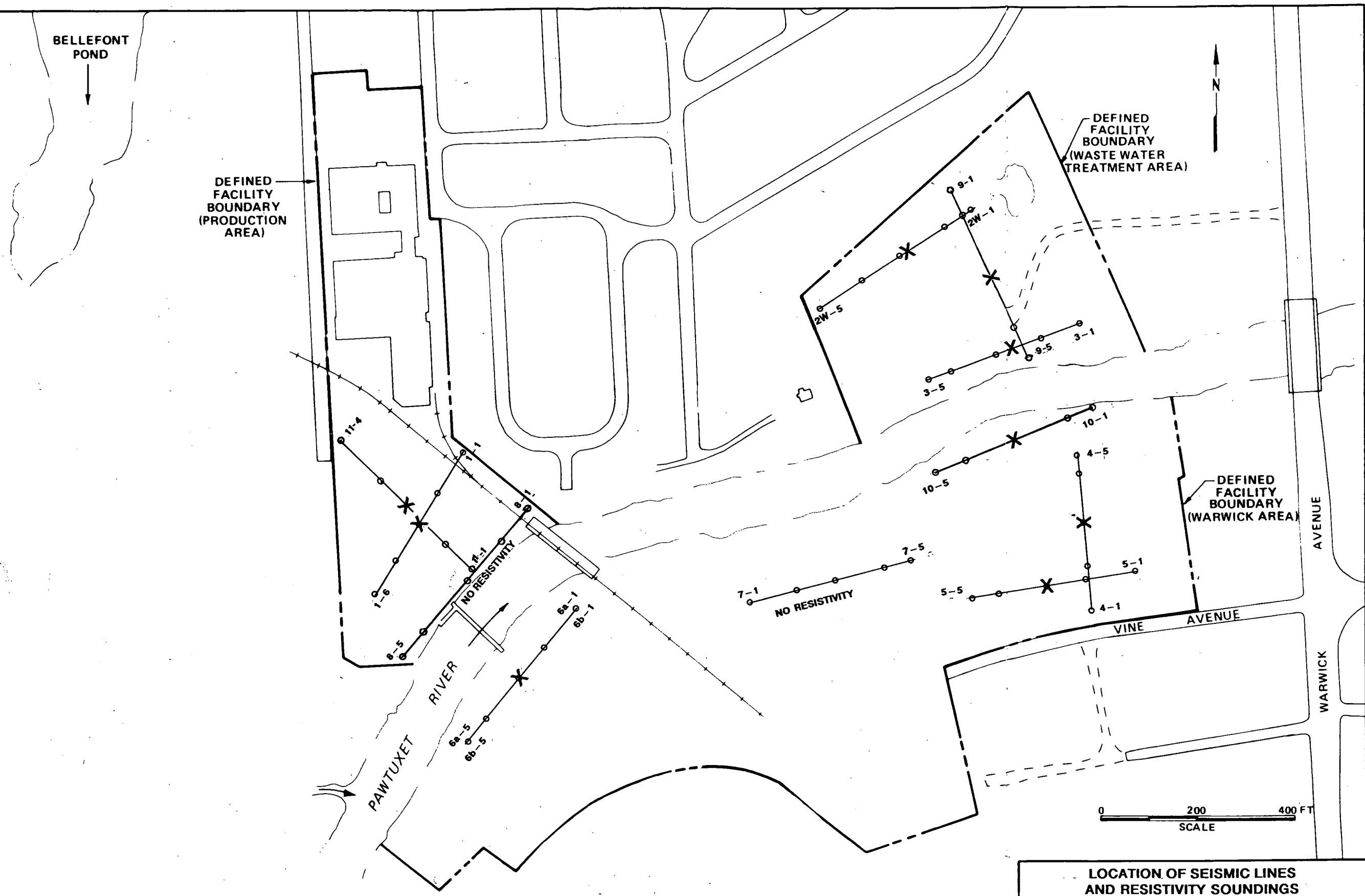
**SOURCE:**

GUIDANCE FOR CONDUCTING REMEDIAL INVESTIGATIONS AND FEASIBILITY STUDIES UNDER CERCLA (INTERIM FINAL) (EPA, 1988).

**OVERVIEW OF TREATABILITY INVESTIGATIONS  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND**

**WOODWARD-CLYDE CONSULTANTS**  
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

DR. BY: BAS	SCALE: NONE	PROJ. NO.: 87X4660
CK'D. BY: AW	DATE: 31 AUG 1990	FIG. NO: 2-2



**LEGEND:**

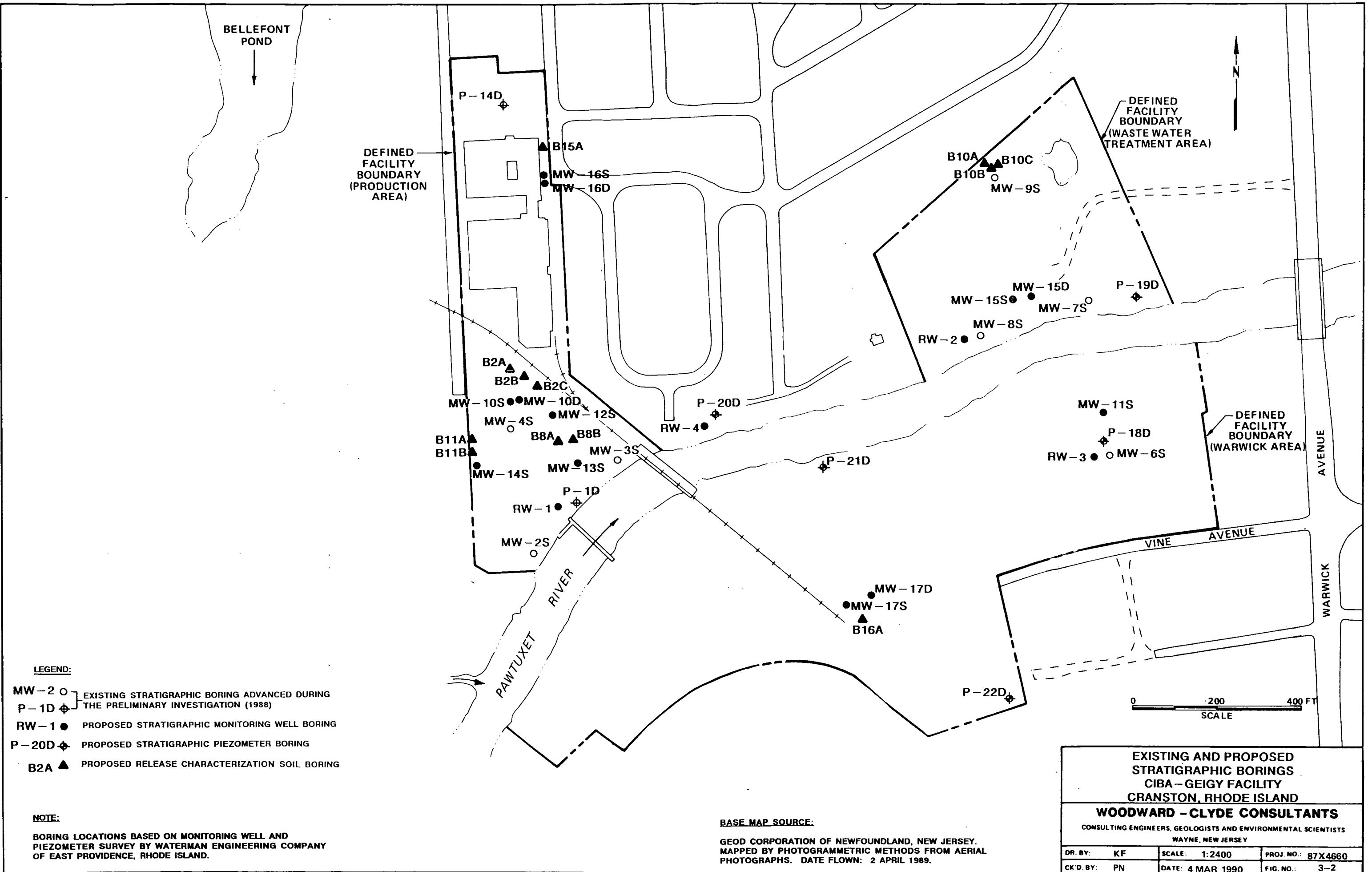
○ — X — ○  
 LOCATION OF SEISMIC LINES AND RESISTIVITY SOUNDINGS PERFORMED BY WOODWARD - CLYDE CONSULTANTS IN OCTOBER 1989 AND JULY 1990. SEISMIC SHOT POINT-SHOWN AS OPEN CIRCLES; X REFER TO THE RESISTIVITY MIDPOINT.

**BASE MAP SOURCE:**

GEOD CORPORATION OF NEWFOUNDLAND, NEW JERSEY.  
 MAPPED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS. DATE FLOWN: 2 APRIL 1989.

<b>LOCATION OF SEISMIC LINES AND RESISTIVITY SOUNDINGS CIBA-GEIGY FACILITY CRANSTON, RHODE ISLAND</b>		
<b>WOODWARD - CLYDE CONSULTANTS</b> CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS WAYNE, NEW JERSEY		
DR. BY: KF	SCALE: 1:2400	PROJ. NO.: 87X4660
CK'D. BY: JDA	DATE: 18 SEPT 1990	FIG. NO.: 3-1





BELLEFONT  
POND

DEFINED  
FACILITY  
BOUNDARY  
(PRODUCTION  
AREA)  
EP-2

DEFINED  
FACILITY  
BOUNDARY  
(WASTE WATER  
TREATMENT AREA)

N

DEFINED  
FACILITY  
BOUNDARY  
(WARWICK AREA)

AVENUE







WARWICK

VINE AVENUE

PAWTUXET  
RIVER

0 200 400 FT  
SCALE

**LEGEND:**

- EP-1  EXISTING PIEZOMETER INSTALLED BY CIBA-GEIGY DURING THE DECOMMISSIONING OF THE FACILITY
- P-1S  EXISTING PIEZOMETER INSTALLED DURING THE PRELIMINARY INVESTIGATION (1988)
- MW-1S  EXISTING MONITORING WELL INSTALLED DURING THE PRELIMINARY INVESTIGATION (1988)
- P-20D  PROPOSED PIEZOMETER
- RW-1  PROPOSED BEDROCK MONITORING WELL
- MW-10S  PROPOSED RELEASE CHARACTERIZATION MONITORING WELL

**NOTE:**

BORING LOCATIONS BASED ON MONITORING WELL AND PIEZOMETER SURVEY BY WATERMAN ENGINEERING COMPANY OF EAST PROVIDENCE, RHODE ISLAND.

**BASE MAP SOURCE:**

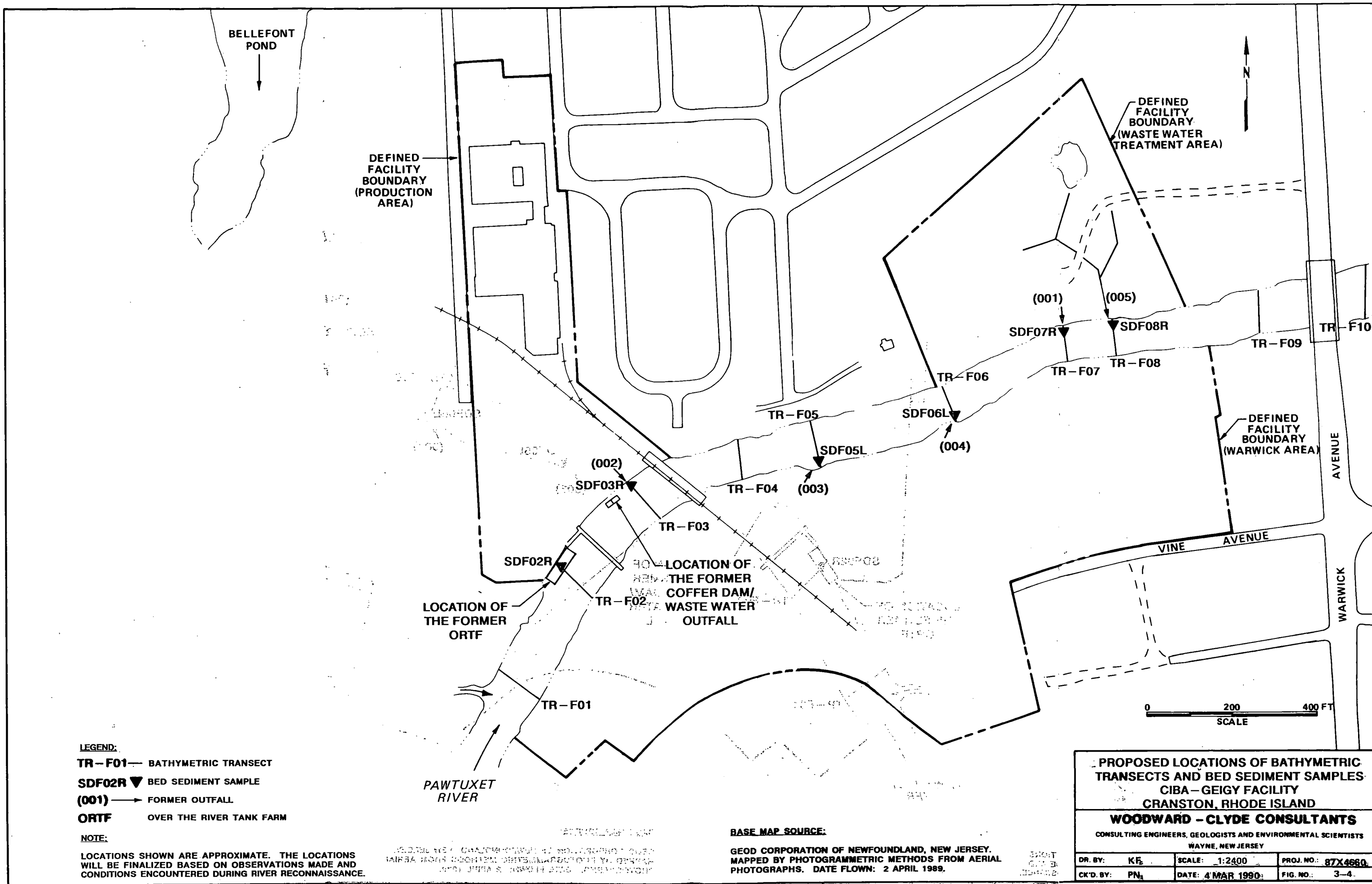
GEOD CORPORATION OF NEWFOUNDLAND, NEW JERSEY.  
MAPPED BY PHOTOGRAMMETRIC METHODS FROM AERIAL  
PHOTOGRAPHS. DATE FLOWN: 2 APRIL 1989.

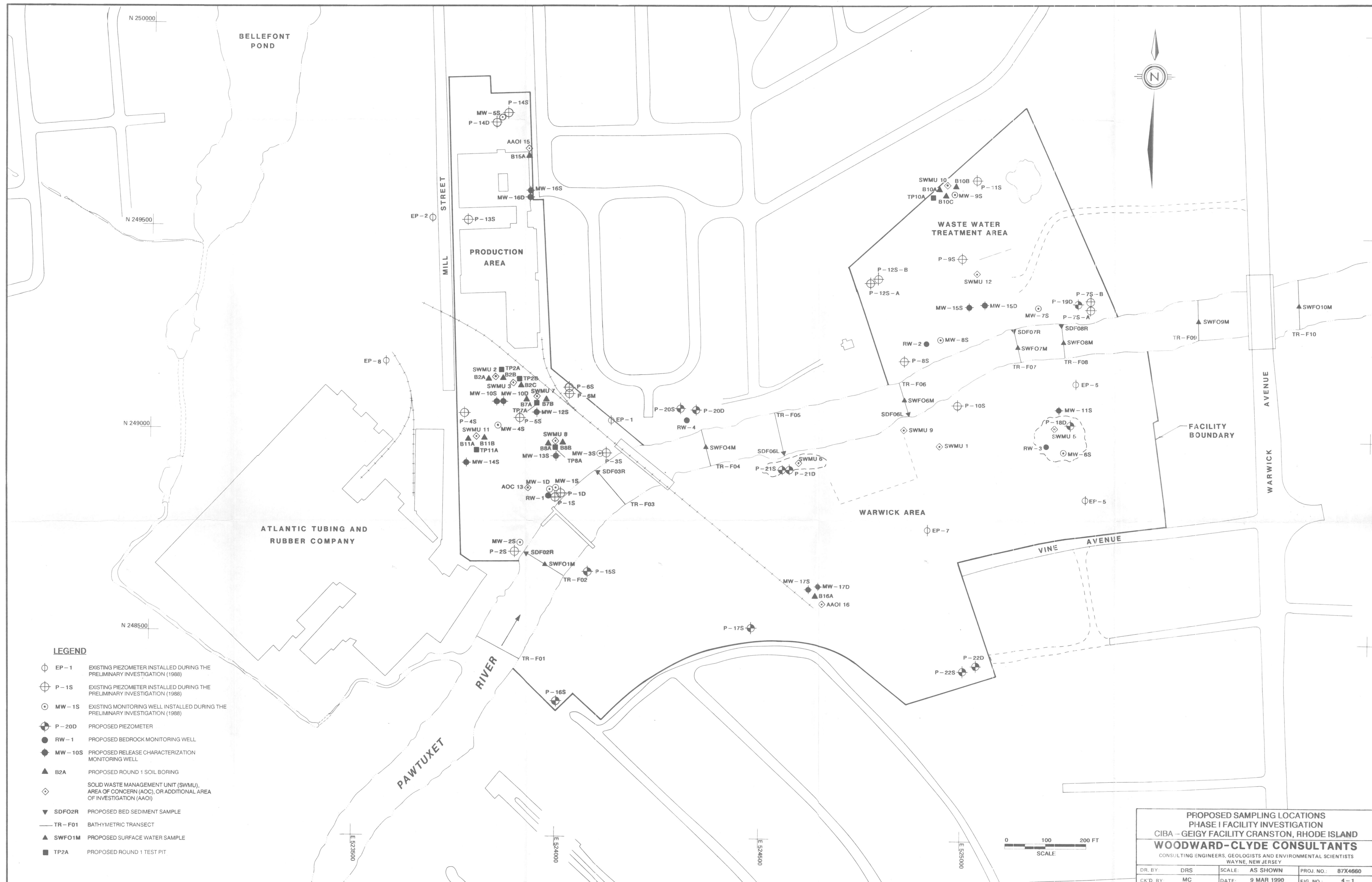
EXISTING AND PROPOSED  
MONITORING WELLS AND PIEZOMETERS  
CIBA-GEIGY FACILITY  
CRANSTON, RHODE ISLAND

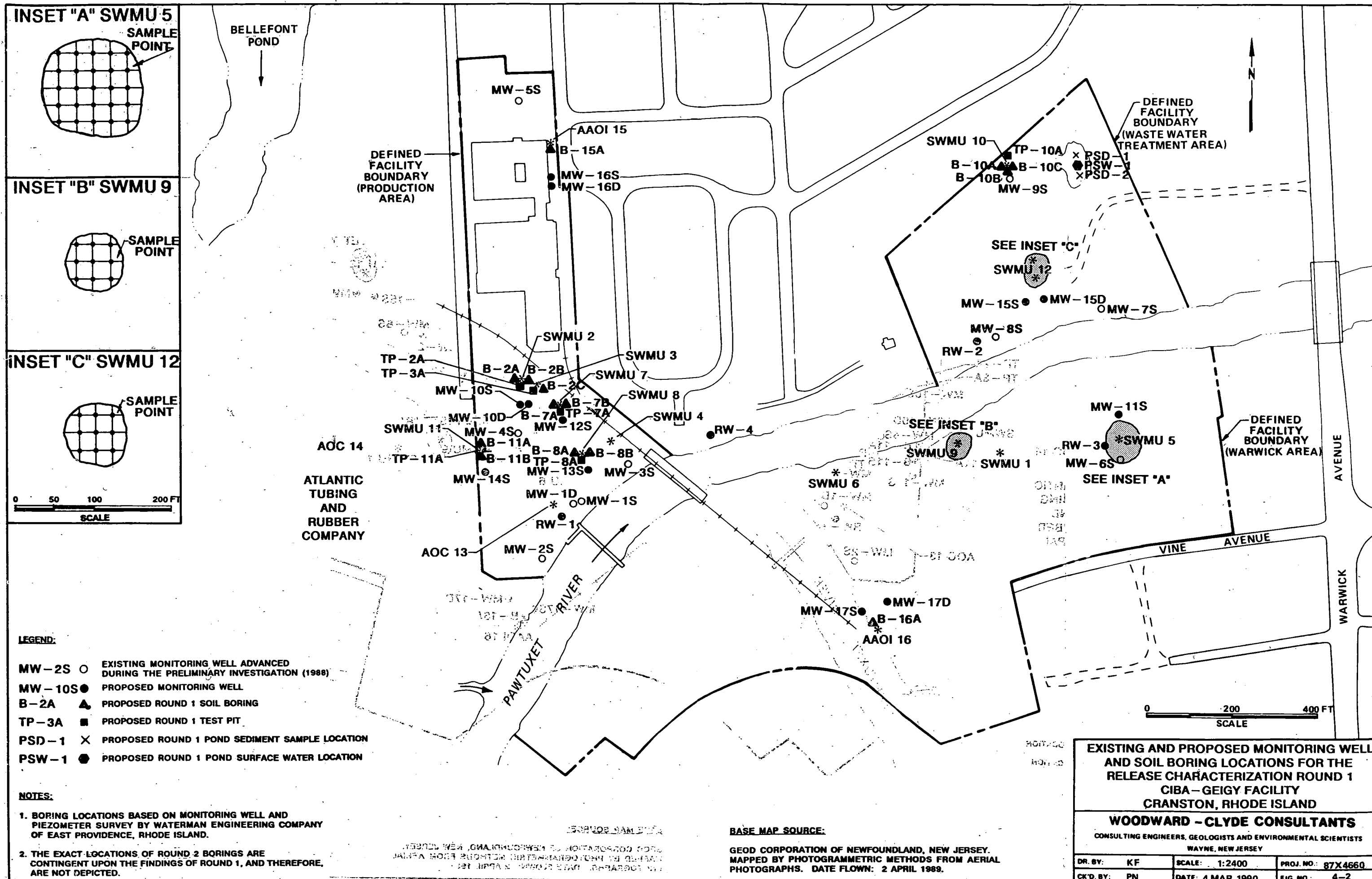
**WOODWARD - CLYDE CONSULTANTS**

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS  
WAYNE, NEW JERSEY

DR. BY: K5	SCALE: 1:2400	PROJ. NO.: 87X4880
CK'D. BY: PN	DATE: 4 MAR 1990	FIG. NO.: 3-3









N	249500
E	524000



<p align="center"><b>PROPOSED SAMPLING GRID, SURFICIAL SOIL SAMPLING – PHASE IB, PRODUCTION AREA</b></p>			
<p align="center"><b>WOODWARD-CLYDE CONSULTANTS</b> CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS WAYNE, NEW JERSEY</p>			
DR. BY:	FWD	SCALE: AS SHOWN	PROJ. NO.: 87X4660
CK'D. BY:		DATE: OCT 31 1990	FIG. NO.: 4-2A



